EXPLORING CHALLENGES OF EVERYDAY ENGLISH LANGUAGE WORDS IN LEARNING PHYSICAL SCIENCES IN GAUTENG-EAST TOWNSHIPS SECONDARY SCHOOLS.

by

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Declaration

I declare that the study entitled **Exploring challenges of everyday English language words in learning physical sciences in Gauteng-East townships secondary schools** is my own work, and has not been submitted before for any degree or examination at any university, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

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DEDICATION

I DEDICATE THIS WORK TO THE LATE PINOT AARON MABUZA, FOR HIS MENTORSHIP AND INSPIRATION.

ABSTRACT

This study, which explores the challenges of everyday English language words in learning physical sciences in Gauteng-East townships secondary schools highlights the difficulties that learners encounter in learning and developing scientific concepts and vocabulary. The study was conducted in four township secondary schools. A questionnaire consisting of 25 multiple choice items, as well as a semi-structured interview were used to collect data for this study. Descriptive statistics was used to analyse quantitative data while qualitative protocol was used to analyse qualitative data. The overall percentage mean scores of correct responses in the questionnaire for schools W, X, Y and Z were 47.2%, 56.9%, 55.2% and 57.2% respectively, which indicated that participants in the study have limited knowledge of everyday English words, when used in a science context. There was no significant gender discrepancy in terms of performance. In-depth analysis of the results revealed that the underlying difficulties were as a result of participants' relative levels of proficiency in the English language, lack of precision in the use of this language, misreading, and confusion in terms of the use of words. Furthermore, the results were consistent with earlier findings from other countries as reported by various authors. The findings will contribute to knowledge about effective classroom instruction and teacher education from the perspective of language in science.

Key Terms: Curriculum Assessment Policy Statement (CAPS), Home Language (HL), First Additional Language (FAL), Second Language (L2), Physical Sciences, Language of Learning Teaching (LOTL), Township Secondary Schools, Science Education.

OKUCATSHANGWA

Kulolu cwaningo, kuhlolwa izinselelo zokusebenzisa amagama asetshenziswa nsuku zonke welimi lwesiNgisi ekufundeni iSayensi ezikoleni zezinga lesibili, emalokishini wabantu abaNsundu empumalanga neGauteng. Kuvezwa ubunzima obuhlangabezana nezingane zesikole ekufundeni nokuthuthukisa umqondo weSayensi nesilulumagama. Uphenyo lwenziwe ezikoleni ezine zasemalokishini. Imibuzo yayiquketwe izinhla ezingamashumi amabili nanhlanu lapho obuzwayo ezikhethela impendulo ekuyiyo, kanye nesinga nhlolokhono yasetshenziwa ukuthola ulwazi oluningi mayelana nalolu phenyo. Izibalo ezichazayo zisetshenziswe ukuhlola ubuningi, kanye nobuqotho kulandelwa umgudu wocwaningo wolwazi olutholakele. Kuvelile emva kophenyo ukuthi izimpendulo ezishaye emhlolweni ngokwamaphesenti kuzikole W,X.Y kanye no Z ngu 47%, 56,9%, 55.2%, kanye 57.2% ngokulandelana kwazo. Lokhu kubonisa ukuthi, abantwana banolwazi oluncane kakhulu ekusebenziseni amagama wesiNgisi asentsheziswa nsukuzonke ukufunda iSayensi. Kubuye kwatholakala futhi nokuthi awukho umehluko ohlukanisa ngobulili babafundi ophawulekayo ngokusebenza kwamagama esiNgisi. Kuphinde kuvele futhi ngokuhlaziya okunzulu, ukuthi kukhona ukwentuleka kwekhono elimini lesiNgisi, nokuthi abafundi abakwazi ukusebenzisa amagama ngendlela eqondile, babuye bafunde ekungeyikho, kanye nokudideka uma besebenzisa amagama. Okunye futhi okuvelayo, yikuthi lemiphumela ihambisana ncamashi neminye imiphumela evela kwamanye amazwe njengoba kubikwe abalobi abahlukene. Lokhu okuvelayo kuzosiza ukulungisa ukufunda kanye nokuqeqesha othisha, mayelana nukufundisa iSayensi ngolwimi lwesiNgisi.

Amagama Abalulekile: Isitatimende senqubomgomo yokuqinisekisa izikole, Ulimi lwasekhaya, Ulimi olwengeziwe lokuqala, Ulimi lwesibili, iSayensi yomzimba, Ulimi lokufundisa nokufundisa, Izikole zamazinga esibili emalokishini, Imfundo yeSayensi.

ABSTRAK

Hierdie studie, wat die uitdagings van alledaagse Engelstalige woorde in die leer van Fisiese Wetenskappe in sekondêre skole in informele woonbuurte in Gauteng-Oos verken, beklemtoon die uitdagings wat leerders teëkom in die leer en ontwikkeling van wetenskaplike begrippe en taalgebruik. Die studie is uitgevoer in vier sekondêre skole in informele woonbuurte. ‘n Vraelys bestaande uit 25 veelvuldige-keuse items, tesame met ‘n gedeeltelike-gestruktueerde onderhoudskedule, is gebruik om data in te versamel vir hierdie studie. Beskrywende statistiek is gebruik om kwantitatiewe data te ontleed, terwyl kwalitatiewe protokol aangewend is om kwalitatiewe data te ontleed. Die algehele persentasie gemiddeldes van korrekte response op die vraelys vir skole W, X, Y en Z was 47.2%, 56.9%, 55.2% en 57.2% onderskeidelik, wat aangedui het dat die deelnemers aan die studie beperkte kennis gehad het van alledaagse Engelstalige woorde om in ‘n wetenskaplike konteks te gebruik. Geen noemenswaardige geslagsongelykheid in terme van prestasie is bevind nie. Indiepte ontleding van die bevindinge toon dat die onderliggende uitdagings die resultaat van deelnemers se relatiewe vlakke van taalvaardigheid in Engels, ‘n gebrek aan presiesie in die gebruik van die taal, gebrekkige leesvaardigheid en

verwarring rondom die gebruik van woorde weerspiëel. Die resultate was verder in lyn met vroeëre bevindinge van ander lande, soos deur verskeie outeurs gerapporteer. Die bevindinge sal bydra tot kennis rondom effektiewe klasonderrig en onderwysersopleiding uit die oogpunt van wetenskaplike taalgebruik.

Sleutelwoorde: Kurrikulum- en assesseringsbeleidsverklaring (KABV), Huistaal (HT), Eerste Addisionele Taal (EAT), Tweede Taal (T2), Fisiese Wetenskappe, Taal van Onderrig en Leer (TVOL), Sekondêre Skole in Informele Woonbuurte, Wetenskapopleiding.

ABBREVIATION AND ACRONYMS

BICS : Basic Interpersonal Conversation Skills

CALP : Cognitive Academic Language Proficiency

CAPS : Curriculum and Assessment Policy Statement

DBE : Department of Basic Education

EAC : English Across the Curriculum

ESL : English Second Language

FAL : First Additional Language

FET : Further Education and Training

HL : Home Language

HSRC : Human Sciences Research Council

IEA : International Association for the Evaluation of Educational Achievement

LiEP : Language in Education Policy

LOTL : Language of Teaching and Learning

NCS : National Curriculum Statement

PIRLS : Progress International Reading Literacy

RDP : Reconstruction and Development Programme

TIMSS : Trends in International Mathematics and Science Study

TVET : Technical, Vocational, Education and Training

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 Introduction and Background

Minchenton and Exley (2009:31) are of the view that much of the research on school science focuses on scientific content, often ignoring the literacies that carry and connect the content. The idea of science literacy is an important driver in a formal school educational context, where the acquisition of knowledge still remains a pertinent issue (Bowater & Yeoman 2013:278). According to Shaw, Lyon, Stoddart, Mosqueda and Menon (2014:622), an emerging body of research, however, has demonstrated that integrating the development of English language and literacy with contextualised science enquiry improves achievement in science. Therefore, the integration of English language literacy and achievement in science warrants further analysis of the extent to which the understanding of the meanings of everyday words used in a language can improve the learning of science.

According to Farrell and Ventura (1998:243), there is a body of research which suggests that word understanding can have a direct bearing on attainment in science education. The everyday English language words also known as non-technical words (Oyoo 2011:852; Farrell & Ventura 1998:243; Maznah & Zurida 2006:73; Gardner 1972:58), are an integral part of the language of teaching and learning. Therefore, learners need to understand that when a teacher explains science concepts in a classroom, they can have specific meanings. Thus, to a large extent, everyday words pose interpretive difficulties for learners, who have to make sense of what is taught in a science class. Setati (2011:7) states that many words have specific meanings in science, which are different from the meaning of the word when used in everyday contexts. For example, the word ‘disintegrate’ would be more acceptable as a standard word when referring to the concept of decay of an unstable nucleus in physics (Oyoo 2011:852). It can thus be argued that an explicit understanding of everyday words in a science context is an integral part of the science classroom, and can assist learning within a specific context.

Science education thus involves dealing with familiar words, such as energy, and giving them new meanings in new contexts (Wellington & Osborne 2001:5).
In this regard, the correct use of everyday English language words in learning physical sciences promotes a better understanding of science concepts, and serves as the basis for effective teaching and learning of science. According to Cummins (2001:1), in an attempt to make science more accessible to students, many teachers attempt to put scientific ideas into "every day" language. However, this also has its challenges, as learners can become confused when words have slightly different meanings in everyday use and in scientific contexts. Abdul-Gafoor and Greeshma (2014:309), state that there is growing empirical evidence of the lack of a clear understanding of the language of the science content, undesirable student outcomes, including difficulty in learning science and a lack of interest in their science content area. This assumption presupposes that the linguistic features of scientific vocabulary present challenges for the comprehension of science concepts. Cohen (2012:74) explains that with regard to science instruction, without an understanding of vocabulary, students are not able to relate content area words to one another or to the information presented, and to grasp the "bigger picture" that the novel terms are used to convey.

The impact of science classroom language on learners in science education has been widely researched in South Africa. Scholars such as; Venkat, Adler, Rollnick, Setati, and Vhurumuku (2009:5-27), have reported their findings on language proficiency and the place of indigenous languages in science education. However, Msimanga, Denley and Gumede (2017:246) argue that very little is known about research conducted in science classrooms in relation to language, both in terms of actual numbers of published research, and in terms of the focus and findings of such research. Research on language misconceptions as a confounding factor in the learning of science has been conducted by Clerk and Rutheford (2000:703). Ferreira (2011) conducted a study on language for Life Sciences (Biology), involving second language learners, and advocated for code switching to help learners to understand science content (Ncube 2014:8).

Nkopodi (1998:2) further states that anecdotes in the interviews that he conducted highlighted language and conceptual difficulties, which could be attributed to language.

However, from the literature that was reviewed, it is evident that there are very few studies in South Africa that have reported on learners' difficulties with the meanings of everyday words, when used in a science context. Oyoo and Semeon (2015:39) point out that the lull in global research on the language of instruction in science education perhaps explains the absence of recent published studies focusing on student difficulties with everyday words used in the science classroom. In light of the paucity of research conducted on the challenges of using English language words in a science context, it is difficult to speculate on specific causes and remedies that are available. However, based on the existing research on the challenges of using everyday words in a science context, it is apparent that the problem merits further investigation.

Studies undertaken by numerous researchers globally, as reported in Farrell and Ventura (1998:243), include the following: Gardner (1972), the pioneer in this research area, who conducted a study using over 600 words among 7000 pupils from 39 different schools in Australia, the Philippines and Papua New Guinea; Cassels and Johnstone (1980), who used 95 words in UK schools; Marshal and Gilmour (1991), who used 45 words in Papua New Guinea. Furthermore, Oyoo (2007) used 30 words in Kenyan and UK schools (Semeon 2014:4). Maznah and Zurida (2006:76) used 25 words with 91 students in Malaysian schools and, more recently, Semeon (2014:90) used 30 words in South African suburban schools with first language learners. The aforementioned researchers have made progress in this area of study. Their findings revealed that the participants had limited knowledge of the meanings of everyday English language words, when used in a science context. This study, in particular, seeks to establish the extent to which Grade 11 Physical Sciences learners from township secondary schools in the Gauteng-east district are affected by the problem of using everyday words in a science context, and how consistent the findings will be with other studies conducted elsewhere.

Oyoo and Semeon (2015:48) contend that further studies suggest that the difficulty is not only evident with second language learners, but is also found with first language learners. Furthermore, Oyoo (2010:276) notes that if comparisons in terms of the levels of performance were made, it could be concluded that the second language sample did worse. However, in this study the researcher only focused on the second language learners in township secondary schools.

The study will also consider gender discrepancies, because it is envisaged that the findings will be irrespective of the gender of learners. According to Farrell and Ventura (1998:245), an interesting feature of their study was that the understanding of non-technical words in science was not dependent on sex. Furthermore, the types and trends in all the studies regarding learners' difficulties with meanings of everyday words were quite similar irrespective of gender and research design (Semeon 2014:15).

1.2 Language in Teaching and Learning in South Africa

A report on the Language of Teaching and Learning (LOTL) published by the Department of Basic Education (DBE) confirms that the English language is still the dominant LOTL for the majority of learners in South Africa (DBE 2011(a):28). The figure below illustrates learner percentages according to language of teaching and learning:

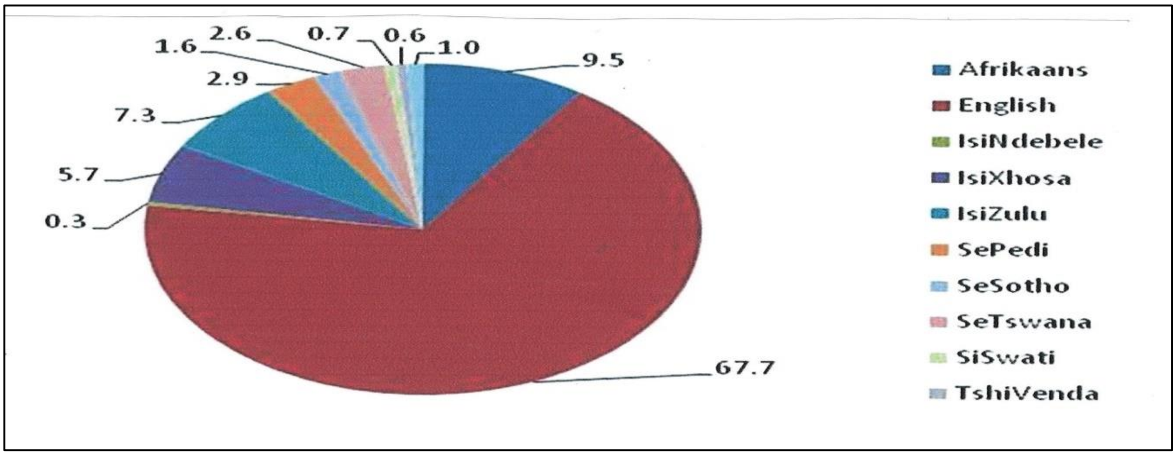


Fig. 1.1 Percentage of learners by language of learning and teaching: 2011 (Source: DBE, 2011a Annual School Survey)

Similarly, a substantial majority of township secondary schools in South Africa are attended by black learners, who use English as a second language, as well as the LOTL. The study conducted by Spaull (2013:5) established that the wealthiest quartile (25%) of students seem to attend vastly different schools than the remaining three quartiles (75%). According to Hlabane (2014:4), English is the home language of less than 10% of the population in South Africa.

However, Figure 1.1 indicates that the English language is the LOTL for around 67% of the South African learner population. The language of teaching and learning for the first three grades in South Africa is predominantly the mother tongue, but in secondary schools, 80% of learners use English as the language of teaching and learning (DBE 2010: 12-16). The discrepancy in the figures of language use and distribution demonstrates the abnormality in language dispensation at schools.

Furthermore, most learners in the township secondary schools study English as the First Additional Language (FAL) in the curriculum of the Further Education and Training (FET) band. According to Spaull (2015:21), English language as the FAL is the largest single subject in matric, with 81% of all matriculants writing the exam in 2014. According to the Curriculum Assessment Policy Statement (CAPS) document, learning a FAL should enable learners to acquire the language skills necessary to communicate accurately and appropriately, taking into account their audience, purpose, and context, and for academic learning across the curriculum (DBE 2011(b):9)**.** In this regard, the CAPS framework on FAL is meant to strengthen the teaching and learning of the English language as a subject and as a LOTL. The trends of learner achievement in English FAL at matriculation level for three consecutive years, as illustrated in Figure 1.2 below, indicate that learners in English FAL are performing significantly better than most subjects. Despite this achievement, learners still struggle with the use of the English language in other content subjects, such as Physical Sciences, as shown in the examinations diagnostic reports.

The subject achievements in the examinations diagnostic reports indicate that the poor language skills of numerous candidates are a major reason for their under-achievement (DBE 2015:5).

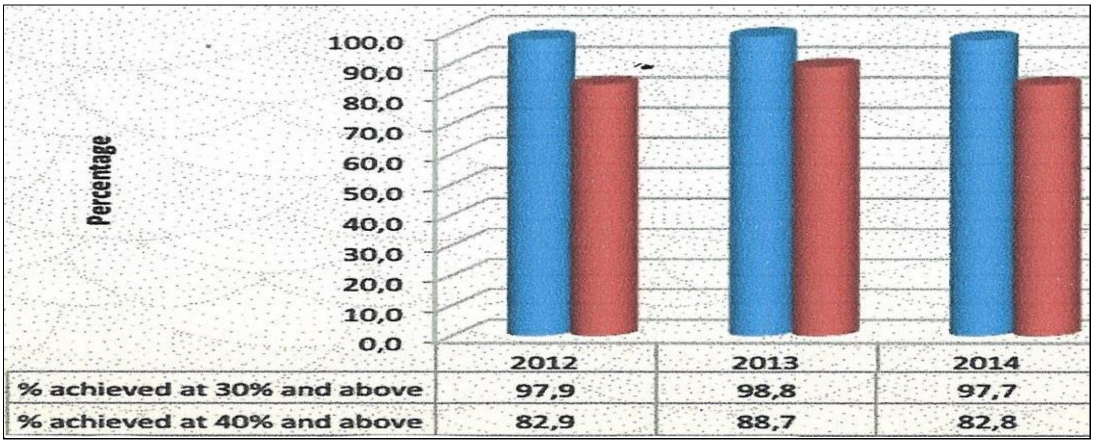


Fig. 1.2: Overall achievement rates in English First Additional Language (Source: DBE, 2015 Diagnostic Report)

1.3 State of Literacy in South Africa

The strategy to strengthen the use of a language in general schooling, and in secondary schools in particular, has manifested in the participation of South Africa in international assessment programmes, such as the Progress International Reading Literacy Study (PIRLS), conducted by the International Association for the Evaluation of Educational Achievement (IEA). The PIRLS of the participating country (South Africa), decided that only schools whose language of learning and teaching was English or Afrikaans from Grade One would take part in PIRLS 2011 (Spaull 2013:19). This body has revealed unsavoury details about the state of literacy in South Africa. Arguably, the most worrying finding of the report was that 78% of South African Grade 4 students are unable to read for meaning. This means that they could not reach the lowest international PIRLS benchmark (Andersen 2017:1).

The target groups for the study were learners whose second language was English, who were learning English FAL as a subject, and whose schools are located in the townships. Furthermore, the participants in the target group were Grade 11 learners who were taking Physical Sciences as part of their studies, as well as their subject teachers. It was anticipated that understanding the difficulties resulting from the misunderstanding of the meaning of words used in science will provide a clear picture of the magnitude of the problem in township secondary schools.

1.4 Significance of the study

The National Senior Certificate examination reports from the Department of Basic Education suggest that Physical Sciences is still underperforming in the National Senior Certificate, compared to most subjects, as illustrated in Table 1.1 below. According to available statistics, many learners in science classrooms find the learning of Physical Sciences a difficult task, as is evident in the comparatively low Physical Sciences matric results over the past few years, i.e. 2012 to 2015, where Physical Sciences attained a national pass rate of 58.6% in 2015 (see Table 1.1).

Table 1.1: Candidate performance in all non-language subjects, 2012-2015

Subjects	2012			2013			2014			2015		
	Wrote	Achieved at 30% & above	% Achieved	Wrote	Achieved at 30% & above	% Achieved	Wrote	Achieved at 30% & above	% Achieved	Wrote	Achieved at 30% & above	% Achieved
Accounting	134,978	88,508	65.6	145,427	95,520	65.7	125,987	85,681	68.0	140 474	83 747	59.6
Agricultural Management Practices	1,223	1,223	100.0	1,417	1,412	99.6	1,615	1,599	99.0	2 040	2 011	98.6
Agricultural Sciences	78,148	57,571	73.7	83,437	67,308	80.7	78,063	64,486	82.6	104 251	80 125	76.9
Agricultural Technology	675	670	99.3	688	687	99.9	705	700	99.3	777	763	98.2
Business Studies	195,507	151,237	77.4	218,914	179,329	81.9	207,659	161,723	77.9	247 822	187 485	75.7
Civil Technology	8,759	8,597	98.2	9,073	8,849	97.5	9,210	8,961	97.3	10 446	10 085	96.5
Computer Applications Technology	44,555	41,183	92.4	44,848	41,348	92.2	40,910	37,379	91.4	41 026	36 778	89.6
Consumer Studies	36,001	34,797	96.7	39,504	39,231	99.3	38,511	37,820	98.2	46 063	45 019	97.7
Dance Studies	435	422	97.0	449	443	98.7	544	543	99.8	528	525	99.4
Design	2,106	2,043	97.0	2,178	2,153	98.9	2,135	2,097	98.2	2 170	2 132	98.2
Dramatic Arts	6,813	6,763	99.3	7,695	7,666	99.6	8,214	8,149	99.2	8 735	8 597	98.4
Economics	134,369	97,842	72.8	150,114	110,869	73.9	137,478	94,779	68.9	165 642	112 922	68.2
Electrical Technology	5,010	4,725	94.3	5,124	4,988	97.3	5,332	5,143	96.5	6 092	5 780	94.9
Engineering Graphics and Design	25,070	23,812	95.0	27,027	26,076	96.5	26,540	24,934	93.9	29 014	27 706	95.5
Geography	213,735	162,046	75.8	239,657	191,834	80.0	236,051	191,966	81.3	303 985	234 209	77.0
History	94,489	81,265	86.0	109,046	94,982	87.1	115,686	99,823	86.3	154 398	129 643	84.0
Hospitality Studies	8,378	8,319	99.3	8,778	8,686	99.0	8,428	8,298	98.5	8 902	8 769	98.5
Information Technology	4,428	4,141	93.5	4,874	4,651	95.4	4,820	4,464	92.6	4 326	4 028	93.1
Life Orientation	522,132	520,502	99.7	569,530	568,311	99.8	542,956	540,810	99.6	660 202	658 308	99.7
Life Sciences	278,412	193,593	69.5	301,718	222,374	73.7	284,298	209,783	73.8	348 076	245 164	70.4
Mathematical Literacy	291,341	254,611	87.4	324,097	282,270	87.1	312,054	262,495	84.1	388 845	277 594	71.4
Mathematics	225,874	121,970	54.0	241,509	142,666	59.1	225,458	120,523	53.5	263 903	129 481	49.1
Mechanical Technology	5,801	5,484	94.5	6,223	5,891	94.7	6,375	6,108	95.8	6 950	6 523	93.9
Music	1,679	1,618	96.4	1,762	1,702	96.6	1,744	1,659	95.1	1 874	1 769	94.4
Physical Sciences	179,194	109,918	61.3	184,383	124,206	67.4	167,997	103,348	61.5	193 189	113 121	58.6
Religion Studies	4,212	4,023	95.5	5,241	4,810	91.8	5,802	5,325	91.8	7 037	6 330	90.0
Tourism	93,254	90,962	97.5	110,565	106,449	96.3	116,179	113,251	97.5	144 643	139 447	96.4
Visual Arts	6,409	6,280	98.0	6,871	6,755	98.3	6,892	6,814	98.9	6 611	6 459	97.7

(Source: DBE, 2015 NCS Examination Report)

There is general consensus amongst learners and teachers regarding the significance of conceptual understanding in science learning. It is argued that concept formation and learning are an integral part of the science classroom and should be developed prior to the analysis of discourse in the science classroom (Adams 2015:330).

The importance of science vocabulary in the conceptual understanding of school science has been demonstrated by the DBE's commitment to its policy of language across the curriculum. To support the implementation of English across the Curriculum, in 2015, the DBE printed and distributed the materials on the Strategy on Teaching English Across the Curriculum (EAC), as well as a Teachers' Manual to implement EAC in all subjects (DBE 2015:21). Through this policy, the subject teacher of a content subject also becomes a language teacher in the classroom.

The difficulties that learners encounter in the language used in science classrooms result in poor achievements in Physical Sciences. These difficulties often arise when learners cannot use the language in specific contexts. The depth of English language skills required at the level of the secondary school is significant in a science class. According to Hudson (2009:168), teachers cannot explain well in English, but can do so in their mother tongue. Similarly, learners do not understand well in English, but can do so in their mother tongue. Therefore, a poor understanding of science concepts could also be attributed to English language use in teaching and learning. Thus, confidence in the language of instruction can be regarded as key to the success of learners studying Physical Sciences.

It is envisaged that the findings from the study might help in providing suggestions on what is probably a better approach towards resolving the language problem that, in the researcher's experience as an educator, exists in a Physical Sciences classroom. Consequently, learners might understand science concepts better, thereby enhancing their chances of doing well in their schooling career as a whole. Furthermore, more learners might develop an interest in and, passion for

Physical Sciences, and subsequently pursue careers in the scientific field. Lastly, the study will also attempt to recommend a possible solution to understanding scientific language, through publications that will be accessible to the education authorities and general public when completed.

1.5 Rationale for the study

Although available reports state that enrolment in Physical Sciences has grown by 15 098 since 2011, the 2015 total represents the largest number of learners taking Physical Sciences (DBE 2015:20). The enrolments in Physical Sciences as a school subject is still low compared to Mathematics and Life Sciences, which are offered in most secondary schools (DBE 2015:20). Table 1.2 below illustrates these figures.

Table 1.2: Subject Enrolments – 2012 to 2015

(Source: DBE, 2015 NCS Examination Report)

Subjects	Entered 2011	Entered 2012	Entered 2013	Entered 2014	Entered 2015
Accounting	140 849	137 587	147 950	128 779	143 962
Afrikaans First Additional Language	69 287	76 841	88 672	83 866	88 069
Agricultural Sciences	79 680	79 963	85 234	80 194	106 183
Business Studies	191 850	199 506	222 928	212 147	254 188
Economics	136 652	137 645	153 340	140 860	169 937
English First Additional Language	424 346	430 897	464 377	443 145	554 565
Geography	203 805	218 048	244 121	241 321	310 300
History	88 290	96 550	111 459	118 575	158 451
Life Sciences	270 540	283 811	307 062	290 580	355 614
Mathematical Literacy	281 613	297 514	330 329	318 994	398 632
Mathematics	229 371	230 022	245 344	229 888	269 253
Physical Sciences	184 052	182 126	187 109	171 549	197 047

There are various factors contributing towards low enrolments in Physical Sciences. These factors usually prompt learners to choose other subjects, instead of Physical Sciences. It could also be suggested that the high failure rate in Grade 12 Physical Sciences has made the subject an unpopular choice, resulting in fewer learners electing to take the subject at FET level (Muzah 2011:3). Although challenges range from shortage of qualified teachers to the demands of cognitive ability required of learners, it is also difficult for teachers to make Physical Sciences appealing to learners who have no confidence in the language of instruction.

One of the reasons why South African learners do not want to enrol for Physical Sciences in Grade 10, or why they generally perceive science as a difficult subject, could be their failure to understand the language used in the science classroom by teachers, or the language used in the science text books (Semeon 2014:3).

The Constitution of South Africa states that schools can choose to educate learners in any one of the eleven official languages (Sasa 1996:5). Nevertheless, most schools have adopted English language as the language of teaching and learning, despite the fact that the home language for most learners and educators is not English (Setati 2011:9). The South African situation provides a unique opportunity for this study, because it has eleven official languages (RSA: 1996), and each language serves as a first language in most secondary schools, unlike monolinguistic countries, where the study was initially conducted.

1.6 The research problem

One of the objectives of the South African science curriculum is to provide equal access to science for learners from all backgrounds. However, this goal remains elusive, as many students, particularly those from low-socio-economic backgrounds, continue to perform poorly in science (Msimanga et al 2017:245). The South African education system regards Physical Sciences as a 'gate way' or admission requirement of most science careers for post-school or tertiary education. It is a 'gatekeeper' subject in the sense that access to science and science-related degrees at most universities requires a pass in either Physical Sciences or Life Sciences in the National Senior Certificate (Umalusi 2014:27). Furthermore, according to the CAPS document, learners choosing Physical Sciences as a subject gain access to courses in higher education, professional career paths related to applied science courses, and vocational career paths (DBE 2011:9).

The researcher's personal experience as a Physical Sciences teacher has shown that scores of learners, parents and teachers perceive Physical Sciences as a difficult learning area. Tank and Coffino (2014:196) attest to this view, by stating that struggling students also build stronger personal beliefs that science is too complex to learn, and that scientific practices are too difficult. However, poor performance in Physical Sciences has inevitably resulted in the exclusion from entry into science career main streams for many learners aspiring to study at tertiary institutions. It is possible to deduce that the smaller number of scientists and engineers in South Africa can be directly attributed to the poor performance of learners in Grade 12, which is the foundation and entry point for such professions (Muzah 2011:5). Oyoo and Semeon (2015:40), further state that the poor performance and lower enrolments in science mean that South Africa may continue to suffer shortages of qualified mathematics and science teachers, doctors, scientists and many other scientifically oriented professionals.

Meanwhile, the Human Sciences Research Council (HSRC) released the results of their 2015 Trends in International Mathematics and Science Study (TIMSS). This report, which focuses on the quality of school science and mathematics achievement globally, presents an undesirable picture of South Africa. In 2015, 34% of mathematics learners and 32% of science learners achieved a score of over 400 points. This means that only one-third of South African Grade 9 learners demonstrated achievement at the minimal level in mathematics and science (HSRC 2015:6). While the profile of the mathematics and science performance levels changed in all school types from 2011 to 2015, it is clear that the public, no-fee schools still need the most intervention to improve their performance (HSRC 2015:8).

The language problems have been cited by various authors and researchers as a contributory factor to the poor achievement in science, leading to underperformance and exclusion from further studies at tertiary institutions. One of the reasons for the persistent differential achievement in science is language (Msimanga et al 2017:245). Accordingly, the language of instruction and learner achievement is directly related to each other (Krugel & Fourie 2014:219).

This study is therefore, aimed at identifying underlying challenges, and seeks to find remedies that can assist learners to acquire the vocabulary which is commonly used in a science context. Thus, the focus of the study is on the correct use of English language words in understanding Physical Sciences content, thereby making it necessary for learning and comprehending science concepts.

1.7 Purpose, aims and objectives of the study

1.7.1 Main aim

- To investigate learners' challenges in terms of everyday English language words used in learning Physical Sciences

1.7.2 Objectives

- To identify underlying factors affecting learners' understanding of English language words used in a science context.
- To establish whether teachers were aware of the prevalence of problems learners encounter with understanding of English language words used in a science context.

1.8 Research Questions

The following research questions emanating from the rationale of the study will be investigated:

1.8.1 Main question

What are the challenges faced by learners in terms of everyday English language words used in learning Physical Sciences in English as a second language?

1.8.2 Sub-questions

- What are the factors that contribute to the misunderstanding of English language words used in a science context?
- What are teachers' views on the challenges of using English language words in a science context?

1.9 The Profile of Township Secondary Schools.

In the Gauteng East district, like the rest of South Africa's townships, most secondary schools are populated with black learners who come from a low socio-economic background (see appendices H1-H4). According to apartheid legislation, suburban and city schools were previously designated for white students, while township and rural schools were occupied by black students (Ramnarain & Fortus 2013:5).

1.9.1 Curriculum in the Township Secondary Schools.

Most township secondary schools offer tuition in English as a second language. In addition to English FAL, township secondary schools offer a wide variety of subjects in the African languages prescribed in the Constitution, as part of their home languages, except for the Afrikaans language, which is still largely offered in former coloured townships as the FAL. Other learning streams offered by township secondary schools include academic subjects, such as commerce, consumer studies, humanities, mathematics and mathematical literacy, and natural sciences, of which physical sciences is one of the subjects. In addition, there are technical streams that offer various trade subjects, such as engineering graphics and design (EGD), electrical technology, mechanical technology, technical mathematics and technical physical sciences. However, only a few township secondary schools in the Gauteng East district offer technical subjects.

1.9.2 Geographical location of township secondary schools

According to Mampane and Bouwer (2011:114), township residential areas in South Africa originated as racially segregated, low-cost housing developments, in order for African labourers to remain closer to their places of employment within the cities and towns. Similarly, township secondary schools are mostly located on the periphery of towns and cities, where black African people were previously forced to relocate to under the apartheid system of government. Therefore, most township secondary schools are found in locations developed by the previous apartheid government dispensation into residential areas demarcated for black people who live in urban areas.

In the vicinity of township secondary schools, there are the original three or four roomed houses and stands, which were made available for working class black people who could afford to build or buy such homes. There are also well developed housing schemes (normally referred to as bond houses or bank financed houses), which house mostly working and middle class black people, such as artisans, teachers and nurses.

The government initiated housing project, known as the Reconstruction and Development Programme (RDP), started after the 1994 elections, in order to build houses for unemployed and poor black people living in townships, as well as those from rural areas, in which many participating learners reside, The RDP is therefore part of the government's housing strategy in the townships.

1.9.3 The demographic profile of township secondary schools

Most township secondary schools have a high enrolment of learners, who come from the surrounding townships, as well as neighbouring informal settlements. Having to contend with variable learner numbers from one year to the next is part of the dynamic of many township secondary schools (Clark 2015:8). The schools' population consists of learners whose language background is Tshivenda, Xitsonga, IsiZulu, IsiXhosa, Sesotho, Sepedi, IsiNdebele, SiSwati, and Setswana (see appendices H1-H4) as well as the teachers, who also belong to the same languages as learners. Furthermore, in some cases, Coloured, Indian and White teachers are part of the teaching staff in some of the township secondary schools.

In addition, the schools have teachers from African countries such as Zimbabwe, Ghana, Cameroon and Nigeria who teach mainly mathematics and physical sciences. A significant number of township secondary schools have laboratories, though in some instances they are dysfunctional or remain unused due to lack equipment and/or qualified science personnel. The South African Institute for Race Relations reported in 2012 that only 15% of public schools have laboratories and 5% have equipment (Umalusi 2014:71). The administrative offices of the schools are manned by one or more administrators per school, in order to help in the running of the schools by providing services to the school management team and general teaching staff, such as photocopying, typing, printing etc., which are essential to facilitate the teaching and learning process. The premises of the schools are most often taken care of by maintenance employees, classified as general workers who perform duties such as sanitary and environmental wellbeing. Furthermore, each secondary school has patrollers, also known as security guards, who are responsible for securing the school property, regulating entry to the school premises, and ensuring the safety of learners and staff.

1.10 The status quo of Physical Sciences in South Africa

In the South African school curriculum, Physical Sciences is offered as an integration of two subjects, namely physics and chemistry (Ncube 2014:4). It therefore incorporates the disciplines of Physics and Chemistry (Umalusi 2014:93). The Department of Basic Education (2011) describes Physical Sciences (also known as science) as the subject that focuses on investigating physical and chemical phenomena through scientific inquiry, by applying scientific models, theories, and laws, and seeks to explain and predict events in our physical environment (Hlabane 2014:12).

One of the aims of teaching the subject is to equip learners with skills that will enable them to interpret and apply scientific knowledge (Qhibi 2006:13). Thus, the outcomes for learning Physical Sciences are that learners should be able to perform experiments in the laboratory and make other scientific discoveries, such as in research projects, in order to construct scientific knowledge. As the situation stands now, Physical Sciences is taught in most secondary schools in South Africa, including schools in townships.

As a subject, it is one of the core requirements for admission to most science careers at Technical and, Vocational Education and Training (TVET) colleges and universities in South Africa. Furthermore, Physical Sciences is offered at TVET colleges as an elective subject, in other words, it is not packaged with other technical subjects, and can only be recognised as part of the qualification. Learners choosing Physical Sciences as a subject in Grades 10-12, including those with barriers to learning, can have improved access to the following: academic courses in higher education; professional career paths related to applied science courses; and vocational career paths (DBE 2011:8).

Whilst the erstwhile National Curriculum Statement (NCS) and the current Curriculum and Assessment Policy Statement (CAPS), do not categorise assessment according to ability and career interest, the NATED 450 syllabus prior to the NCS and CAPS categorised assessment according to standard grade and higher grade achievements in order to cater for ability and career pathing. The depth score for the matric examination content is remarkably similar across the NCS and CAPS curricula (Umalusi 2014:104). Accordingly, all students, irrespective of their ability in Physical Sciences and career ambitions, are compelled to study a single stream of physical sciences.

1.11 Definition of key terms, concepts and variables

Language of teaching and learning (LOTL)

The Department of Basic Education (2011:38) defines the language of learning and teaching as a language medium through which learning and teaching, including assessment, occurs.

Home language:

Refers to the language that is spoken most frequently at home by a learner (DBE 2010:3).

Curriculum and Assessment Policy Statement (CAPS)

The Department of Basic Education (2011:3) defines the Curriculum and Assessment Policy Statement as a policy document that stipulates the policy on curriculum and assessment in the schooling sector.

Physical Sciences

Physical Sciences is a subject that makes use of scientific enquiry and problem solving techniques to investigate physical and chemical phenomena (DBE 2011:8).

First Additional Language (FAL)

Refers to a compulsory language subject learners have to study at secondary school FET phase (DBE 2010:3).

Secondary school

A secondary school is an ordinary school offering at least one grade in the range of Grades 8 to 12, and no grades in the range of Grades 1 to 7 (DBE 2015:44).

FET band

This encompasses Grades 10 to 12 offered at ordinary schools (DBE 2015:44).

Learning Area

A unique field of knowledge associated with a particular subject in the GET and FET bands of the Department of Basic Education.

1.12 Chapter outlines

Chapter 1 – Introduction and background to the study.

This chapter served as an orientation to the study, elaborating on the various perspectives of the language challenges posed by the English language, particularly in terms of the meanings and use of everyday words in understanding science content. It further discussed the impact of the challenges in teaching and learning Physical Sciences in South Africa. It concluded by providing the background, significance and relevance of the study, including the aims and objectives of the study.

Chapter 2 – Literature review and theoretical framework

This chapter focused on relevant literature on the use of English language words in a science context, citing previous research in this regard. The chapter also discusses theoretical framework that was used in the study.

Chapter 3 – Research methodology

This chapter discusses the research approach, research design and methodology, and provides a description of the instruments used to collect data. It also explains how data was analysed, as well as how the instruments were piloted. Ethical considerations are also discussed in this chapter.

Chapter 4 – Analysis and findings

The analysis of data, responses to research questions and outcomes of the study are presented and discussed in this chapter, in order to support the aims and objectives of the study**.**

Chapter 5 – Conclusion and recommendations

This chapter concludes the study, and describes how the research questions were answered by the study. The chapter also makes recommendations for possible solutions to the problems of English language word use and understanding in science context.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Literature review

2.1.1 Introduction

One of the important features of science is the richness of the words and terms that it uses (Wellington & Osborne 2001:3). However, the skills required to master the basic language are most certainly acquired through word understanding. Without an understanding of meaning of words, the underlying concepts that they refer to will never be fully mastered (Cohen 2012:73). This is particularly true when words are used to explain science concepts encountered mostly in science classrooms, in order to make sense of what is taught. The challenge with the use of language, in particular the meaning of words which constitute essential vocabulary for learning science, is the source of difficulty with the learning process. According to Tank and Coffino (2014:196), since science vocabularies are very complex and demand considerable effort to understand them, knowing science vocabularies helps students to build linkages between different science concepts and ideas. In this respect, words which are frequently used in everyday communication are better understood than when they are used in a science context.

In this part of the chapter, the review of literature will include the following: historical perspectives of the language, language policies in education, the nature of science classroom language, the importance of language in science education, challenges of English as a second language in a science classroom, language demands for learning and teaching Physical Sciences, the challenges of using English language words in science teaching and learning, the difficulties associated with the meanings of everyday words in a science context, and implications for science teaching and learning.

2.1.2 Historical background to language in South Africa

In a South African context, the use of English as a second language in general schooling for most learners can be traced back to the colonial, missionary and apartheid systems of education. Christie (2008:32) reported that during the whole period of the Dutch regime in the Cape, formal elementary education meant instruction in doctrines of the Dutch Reformed Church, while some of the abler pupils would also acquire the basics of reading, writing and arithmetic. As with the colonial era, missionary schools were established to provide basic education to black people, in an effort to promote literacy and numeracy, as well as to instil Christian values. The missionaries saw education as a way of achieving their own aim of converting people to Christianity, and of establishing themselves and their work (Christie 2008:71). Mda (2000:156), is of the opinion that the intention, however, was not to promote African languages to the level of English and Dutch, but to enable the African people to read the Bible. During the apartheid era, the Afrikaans language was imposed as the medium of instruction on the black majority of South Africans. According to Booyse, le Roux, Seroto and Wolhuter (2011:228), with regard to the education of non-white groups in the country, the Soweto unrest of 1976 and its aftermath made it clear to the government that an impasse had been reached. In response to the revolt, the English language became an alternative instructional medium at most public schools, although Afrikaans continued to be taught as a subject in some township secondary schools, particularly the former coloured townships. It was also used as a medium of instruction by predominantly white Afrikaans speaking South Africans in public schools.

The transition to the English language medium was neither easy nor smooth for the majority of South African students who are second language speakers with inadequate levels of proficiency in the language of instruction. According to Wildsmith-Cromarty and Gordon (2009:362), this finding is strongly reinforced by Bunyi (1997), who conducted a study in the Kenyan educational context. He proposes that the use of English as a medium of instruction (MoI) for the teaching of science, in particular, deprives learners of the opportunity to apply what they are learning to everyday life.

2.1.3 Language and education policy in a democratic South Africa

The South African Constitution (RSA, 1996) acknowledges the right of all learners to receive education in the official language or languages of their choice in public educational institutions, insofar as this is reasonably practicable (de Wet 2002:119). According to the legislative framework of the Constitution, South Africa is regarded a multilingual country with eleven official languages, namely, Sepedi, Sesotho, Setswana, SiSwati, Tshivenda, Xitsonga, Afrikaans, English, IsiNdebele, IsiXhosa and IsiZulu, all of which should enjoy equal status and respect. However, English and Afrikaans, to a greater extent, remain widely used in government institutions, such as national and provincial home affairs departments, citing practical purposes such as birth and death registration documentation and procedures in courts of law, with the exclusion of indigenous languages included in the Constitution. In the South African context, learners, teachers and local communities often experience difficulties in understanding newly-coined terms developed by experts on language boards and other government bodies tasked with language monitoring and development (Wildsmith-Cromarty & Gordon 2009:363). Despite these provisions, English has expanded its position as the language of access and power since the democratic elections of 1994, which has resulted in the relative influence of Afrikaans shrinking, and African languages being effectively confined to functions of ‘home and hearth’ (Probyn 2006:391).

The government also continues to conduct its business using the English language, such as in parliamentary caucuses in the national, provincial, and local spheres of legislature addresses, as well as at press briefings and conferences. According to Granvile, Janks, Mphahlele, Reed, Watson, Joseph and Ramani (1998: 254), all these attempts to marginalise indigenous languages defeats the recommendations of the Language Task Action Group (LANGTAG), a body commissioned by the Minister of Arts, Culture, Science and Technology in 1995 to establish South Africa's language-related needs and priorities.

In education, the English language has been promoted politically, socially and economically through the legislative framework, which supports its use as the language of instruction for teaching and learning for general schooling in the 'new South Africa'. Unfortunately, one of the leading factors militating against the success of the policy is the lack of political will in leaders and in South African society. On paper, all languages are equal and are to be treated equally, but in practice, the two former official languages, English and Afrikaans, are still held in esteem by all who aspire to be successful socially and economically (Mda 2000:162). In black communities, parents, school governing bodies and other lobby groups continue to support English language as LOTL, with some parents sending their children to ex-model C schools (public schools formerly for whites only) and private schools to learn English as first language. According to Fengu (2017:6), Thwala, in an article, writes that many black parents are preventing efforts aimed at educating their children in their mother tongue, out of fear that this will adversely affect their future job prospects. In the business and economic sector, the English language is preferred by industries such as multinational companies, who insist on English communication as a requirement for their global marketing strategy, in order to maximise profits in their companies. Mothata (2000:14), states that one of aims of Language in Education Policy (LiEP) is to support languages which are important for international trade and communication.

The use of the English language has predominantly permeated all levels of schooling in South Africa, namely primary, secondary and post-school education. In particular, in most township secondary schools, learners receive their tuition in English, and study it as a FAL subject in their school curriculum. Since the English second language learners are in the majority in South Africa, gaining a high level of proficiency in the LOTL is considered a very first step, as any learning is only possible in a language in which a learner has some proficiency (Oyoo & Semeon 2015:42). The language policies which serve as guidelines for schools are summarised in the Language in Education Policy in terms of the National Education Policy Act and the norms and standards regarding language policy, which are found in the South African Schools Act (SASA) document (Mothata 2000:2-16).

These acts of parliament aimed to regulate language use in the implementation of the curriculum across all racial groups. The new Language in Education Policy is thus perceived as an integral and necessary aspect of the democratic government strategy of building a non-racial nation in South Africa (DBE 2010:3). However, none of the schools has developed a language policy according to the Language-in-Education Policy legislation. In effect, although the Constitution affords learners the right to learn in the language(s) of their choice, this right is tempered by the state's inability to practically provide for its implementation (DBE 2010:6).

2.1.4 The nature of science classroom language

Science learning involves being able to communicate about science using specialised language designated for the exploration and delivery of the real world (Evans & Avila 2016:291). Creating and conveying scientific information in a science classroom mostly involves using everyday words in conjunction with science terms to enhance science learning. Cohen (2012:74) argues that the marriage of literacy and science also enables individuals to confront questions that require the use of scientific thinking and understanding of scientific information. However, this will make it difficult to explain certain scientific concepts, such as power, energy, force, and others, since one word is used to refer to these terms in most African languages (Muzah 2011:86).

School science is characterised by a vast amount of words which are common in science textbooks and other science learning material, such as laboratory instruction manuals, learner workbooks, worksheets, study guides and e-learning media (tablets and smart classrooms), which are currently being used in Gauteng schools. These words are characteristic of school science, underpinning the learning of Physical Sciences, although they can be collectively used in other natural sciences, such as technology and life sciences. Furthermore, these words are known by the international science community to constitute the language of science when used collectively.

According to Oyoo (2011:851), the classroom instructional language used by the science teacher and in science textbooks has two parts, namely the technical component, and the non-technical component.

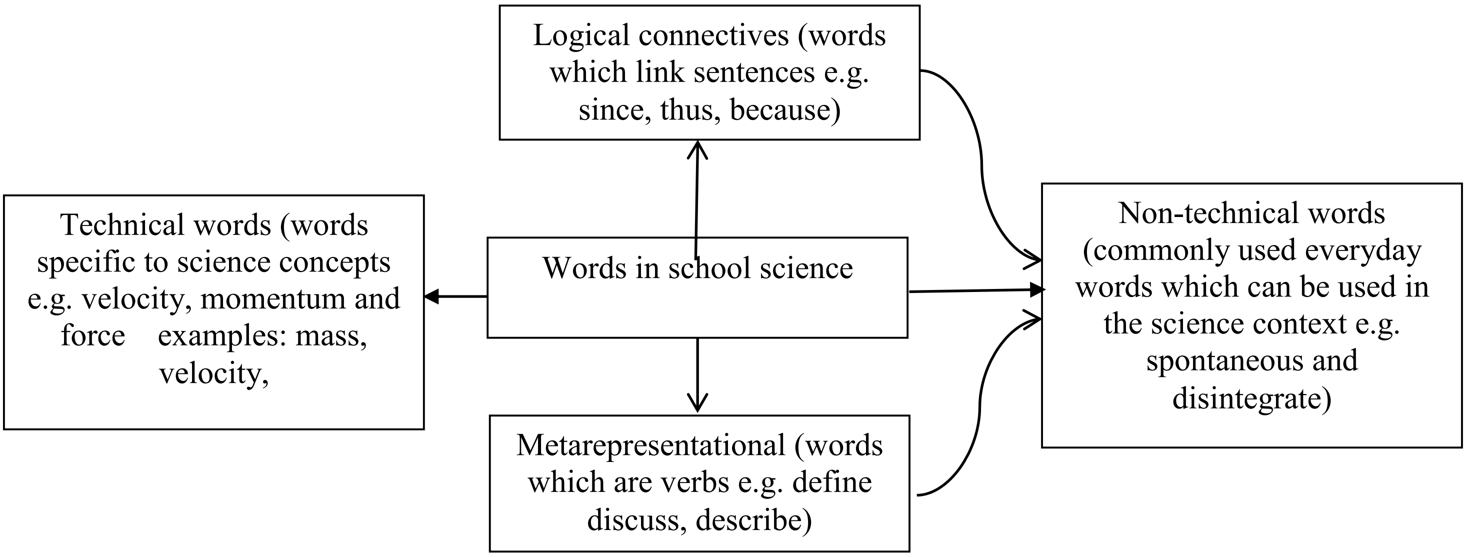


Fig. 2.1: A quad view of words used in school science.
(Source: Modified from Oyoo, 2007)

2.1.5 Technical words

Technical language can consist of words unique to science such as sedimentary, pressure and erosion (Hodgson-Drysdale 2014:54). These technical words are made up of terminologies specific to a science subject. In the text, the words 'accelerates' and 'velocity' are technical words (Hlabane 2014:33). According to Oyoo and Semeon (2015:39), these examples of technical words seem to give an identity to particular subjects and / or the science discipline.

Therefore, technical words are also part of science texts and general science communication. The large technical vocabulary is undoubtedly its most characteristic feature, reflecting the specialised subject matter of scientific domains of enquiry (Crystal 2010:400). Furthermore, technical words are snowballing in quantity from primary school science to secondary school science and higher education. Maximal acquisition of technical words strengthens science vocabulary assimilation, which is essential for academic excellence. This suggests that if too few technical words are known by learners, gaps in comprehension will be created, and learners will have difficulty in constructing meaning.

2.1.6 Non-technical words

The non-technical component is the main part of the classroom language (Ncube 2014:14). According to Oyoo and Semeon (2015:44), the non-technical component of science classroom language, on the other hand, is made up of non-technical words, and defines or gives identity to the particular LOLT in use in a classroom, or the language of a science text. This is obviously dependent on the extent to which we are able to tell which language is in use and whether the language is English or any other language. The non-technical words are normally spoken or written in science classroom communication, such as the word "*spontaneous",* which could have other meanings when used in everyday conversation. According to Cassels and Johnstone (1985), non-technical vocabulary refers to terms that have one or many meanings in everyday language, but which have a precise and sometimes different meaning in a scientific context (Zisanhi 2013:11).

Everyday words are too vague for many scientific purposes (Crystal 2010:400). Thus, effectually learners need to understand the meanings of everyday words in the context of use during science learning process. The non-technical words in science context, as part of the language typical of science subjects, may be considered to constitute a language characteristic of school science (Oyoo 2011: 852). In science classes when students participate, they generally utilize everyday language with limited use of words in a science context (Tank & Coffino 2014:198). This effectively suggests that learning in a science classroom can only occur when non-technical words are understood and correctly used in a science context (Sithole 2011:6).

Furthermore, there are other categories of words that are found in science texts and communication which are non-technical in nature. The category of logical connectives includes words or phrases which serve as links between sentences or between a concept and a preposition, such as 'since', 'because', conversely' and 'therefore' (Oyoo 2011:853). It is well known that scientific language relies heavily on the use of logical connectives (Mc Naught 1992:234). The logical connectives are also important for the learner's participation and understanding of the educator's science talk and the science learning process. This is because sentences and concepts in the teacher's classroom talk are linked to such logical connectives (Ncube 2014:16). The meta-representational terms are words or terms which signify thinking and include metalinguistic verbs. The latter are words which take the place of the verb, such as, 'define', 'suggest', explain', 'describe' etc. (Oyoo 2011:853). They are often pointers indicating that learners experience difficulties in understanding examination questions, due to inadequate exposure to meta-representational words.

It is these words, often used in examinations to indicate the content, as well as the structure and emphasis required by the examination questions, that Bearne (1999) and Bulman (1988) have respectively, recognised as the "key terms" or "operative words" (Oyoo 2008:106). However, the focus of this study is only on non-technical words in the science context, as used in the English language.

2.1.7 The importance of language and the meaning of words in science learning.

The significance of language in the learning of science has been widely discussed and emphasised from many perspectives (Seah 2015:4). Tong, Irby, Lara-Alecio and Koch (2014:413) state that developing science learning and literacy includes learning the language, concepts, and culture of science. Language is a tool for conceptualising content and knowledge, and expressing oneself accordingly in a rational, "academic" style, based on subject-specific conventions and registers (DBE 2014a:8).

According to Watters and Diezmann (2016:41), understanding and valuing the role of language and social discourse that epitomise the community of learners in the context of science presents a new way of understanding what counts as knowledge in the classroom. This description of a language suggests that it can be regarded as a powerful tool for any meaningful verbal and non-verbal communication in teaching and learning science. The language used in a formal environment such as a school, and more specifically a science classroom, is not a mere social communication, but involves communication which is aimed at equipping learners with valuable science knowledge. The words, tenses and sentence structure used in communicating science concepts affect the way in which learners respond during a teaching-learning encounter (Asabere-Ameyaw & Ayelsoma 2012:55). The inevitable general inference is that language mastery is the key to science learning, as well as to creativity in the sciences (Brock-Utne 2013:91).

The findings of the study conducted by Oyoo (2011:849), have suggested that the use of (instructional) language in science texts and the science classroom can have a major influence on the level of students' understanding and retention of science concepts. This notion supports the view that the quality of communication becomes more important in promoting the learning and understanding of science. For example, language conventions are used in arguing or debating issues in science, formulating hypotheses or communicating inferences, and in negotiating meaning by questioning, paraphrasing or elaborating during scientific interactions with learners (Asabere-Ameyaw & Ayelsoma 2012:55). Thus, learners' understanding of scientific concepts is frequently gauged by the rate of their verbal responses in class deliberations. The approach here is that one needs to understand the language before one can decode the science in the knowledge that is presented (DBE 2014a:8).

Therefore, a functional approach to language and content can help both teachers and students to go beyond traditional lessons in grammar and vocabulary, as well as to understand how language is used to create meaning in science (Hodgson-Drysdale 2014:59).

The learners in science classrooms often struggle to cope with grasping and understanding science concepts when they are afforded the opportunity to read, write and communicate their understanding of what is taught in a classroom. Learners (in all subjects) use listening, speaking, reading and writing skills to order and classify thoughts, information and to learn language appropriate to the subject (DBE 2014a:8). In the classroom, learners often use listening, reading and writing skills in order to classify their thought processes and enhance their understanding. Doing, talking, reading, and writing science affords students language and content learning opportunities, where they engage with both receptive (listening and reading) and productive (talking and writing) language, which can accelerate language and science learning (Bravo & Cervetti 2014:242). Furthermore, learners who are actively engaged in science lessons through their written work, reading of learning material, and listening to the explanations provided by teachers, often achieve science understanding.

Listening and speaking, in particular, are essential components of oral communication in a science classroom. Oral responses are an integral part of the school culture (Schunk 2004:8). Meanwhile, critical listening enable learners to collect and synthesise information, and to construct knowledge, and this often helps them to express their opinions. This is achieved when learners are able to ask questions, elaborate on their responses, and provide feedback when required. Tank and Coffino (2014:195) further state that participating and expressing science understanding through talk is an integral part of communicating the knowing and doing of science. Listening and speaking further enhances group work activities, such as project-based learning, where groups of learners are given assignments requiring them to exchange ideas in describing concepts, phenomena, principles and theories. In the final analysis learners are able to support their own ideas and apply them in new contexts in real life, such as in their place of work after school.

According to Tong et al. (2014:414), while little is known about the integration of reading and science, literature on student characteristics that influence academic achievement in these areas is not scarce.
The significance of reading in a science classroom is that it helps to engage learners in accessing scientific information. Kaldenberg, Watt and Therrien (2014:160) maintain that in science classes, for instance, students are often required to use reading skills to comprehend material from textbooks, complete practice problems, and access information from additional resources. Whilst reading, learners view and interpret pictures by creating mental images through visual scanning, in order to bring the text to life. The integration of reading strategies into science instruction provides a means to increase student achievement in content areas (Kinniburgh & Baxter 2012:1). Thus, purposeful reading helps to activate learners' prior knowledge, as well as their ability to evaluate a text and ask questions. Consequently, encouraging learners to read different types of science texts in class will help them to understand the important words required for science learning (Hlabane 2014:42). Furthermore, learners will be able to monitor their comprehension levels, by summarising the main ideas of the science texts and other essential science learning material. In doing so, learners must be able to identify the most important ideas, clarify meaning, and develop a deeper understanding of the text.

Writing is an essential skill for science, as it helps students to learn how science texts are constructed, in ways that are unique to the discipline (Hodgson-Drysdale 2014:59). According to Lindquist and Loynachan (2016:48), engaging students in thoughtful, intentional writing in and out of science notebooks plays an important role in science education. In a science classroom, the lesson that is presented should prompt learners to test their understanding through writing activities in their notebooks and workbooks, so as to organise their thought processes and ensure that what is learned is understood. Writing class activities and homework activities, for example, help learners to perfect their understanding of the subject matter. During the process of writing, learners are taught how to generate ideas, think about the purpose and audience, write drafts, edit their work, and to present a written product that communicates their thoughts (Hlabane 2014:20).

Through the exercise of writing, teachers are able to engage all learners, monitor learners' progress, and identify gaps and shortfalls in instruction. Science teachers need specific strategies to develop writing skills, along with science content (Jimenez-Silva & Gómez 2011:23). Through this, learners are also able to recognise the structure of different types of science texts, and the language features, such as drafting experimental procedures, proof-reading instructions, editing laboratory reports, and the importance of word order in presenting their own observations and views. Therefore, one way of approaching the cognitive process involved in acquiring writing skills is by examining the nature of learners' written forms of communication, and the errors contained therein (Narang 2013:34). These efforts contribute towards promoting independent thinking, as learners will be able to express their points of view regarding the scientific world.

2.1.8 Language demands for learning and teaching Physical Sciences

The question of language choice and practices for science teaching, learning and assessment is an important question that urgently needs to be addressed (Mifsud & Farrugia 2017:99). Most science learners and educators in the township secondary schools would admit that learning Physical Sciences demands sound communication skills in the English language, which is the language of instruction. While language demands are significant, the chances are also high that learners will learn important English language skills, as well as science content (Setati 2011:33).

The demand for English language proficiency for learning in general, and science learning in particular, can be explained by two levels of language communication, namely basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP). Over time, Cummins began to describe surface fluency as basic interpersonal conversation skills (BICS), while higher level proficiency was referred to cognitive academic language proficiency (CALP)

(Hlabane 2014:42). BICS is often used in informal settings, such as everyday communication between adults and children, and amongst children themselves. This kind of communication normally demands basic skills, and occurs contextually in concrete situations, such as in the playing of games.

CALP, on the other hand, involves formal and structured dialogue, which is normally used in classroom situations. CALP includes not only the understanding of the content area vocabulary, but skills such as comparing, classifying, synthesising, evaluating, and inferring (Tong et al. 2014:412). According to Cummins, BICS is cognitively undemanding and context- embedded, since contextual cues are available to both speaker and listener involved in the conversation. On the other hand, CALP involves language that is content-reduced and highly demanding cognitively, such as, the language of science (Othman & Saat 2009:314). In a science classroom, learners rely on CALP to develop and understand scientific concepts, and to be able to communicate them effectively. Learners who are yet to develop their cognitive academic proficiency could be at a disadvantage in learning science and other academic subject matter (Asabere-Ameyaw & Ayelsoma 2012:56).

According to the CAPS document (DBE 2011a:14), teachers of Physical Sciences should be aware that they are also engaged in teaching language across the curriculum. Thus, teachers must be able to recognise and address the language demand, in order to help learners to have access to science knowledge through the understanding of key science concepts. Their interaction and participation with learners in a classroom discourse are essential to learners' full development of the necessary language skills for acquiring science knowledge. Furthermore, such skills are ideal for providing learners with an opportunity to explore science phenomena in the context of Physical Sciences. The challenge of mastering language skills is mostly attributed, not only to the level of proficiency in the language of instruction, but also to understanding the spoken and written words. Learners' inability to explore the meanings of words that they come across in the daily lessons, and in any other form of classroom communication, is the source of their difficulty in meeting the language demands in classroom communication. The language demand on learners has a negative impact on their academic achievement and excellence, especially for learners who have intellectual ability. The language skills and strategies could be transferred to content subjects, depending on the language demands and the support required in different content subjects (DBE 2014b:9).

Based on the level of language mastery indicated in their responses, teachers can decide whether adequate learning has taken place, or whether additional instruction is needed because students do not fully comprehend the material (Schunk 2004:8). In this sense, the acquired language skills reinforce their scientific vocabulary through word understanding. The extent of learners' competence in science vocabulary acquisition will be demonstrated by their effectiveness in all tasks that require reading, written and oral expressions.

When teaching Physical Sciences, the teacher speaks and demonstrates during lessons and practical investigations, while learners listen and ask questions where they do not understand, and participate in classroom deliberations. In doing so, they develop the capacity to assimilate valuable science knowledge. Successful approaches to science teaching for English learners also address the language demands of science, by infusing science instruction with practices which amplify the language of science, without diluting the content (Bravo & Cervetti 2014:233). This situation requires the alignment between learners' understanding and teachers' explanation.

2.1.9 The challenges of English second language in science classrooms

Research over a long period of time has continued to highlight problems in the teaching of science in schools (Watters & Diezmann 2016:25). There has been a lack of clear understanding, based on published research, regarding how to most effectively assist second language learners of English to acquire science knowledge, while at the same time eliminating academic disadvantage in science and reading (Tong et al. 2014:423). Romaine (2002:8) states that in most parts of the world, schooling is still virtually synonymous with learning a second language. Learners' limited proficiency in a second language hinders their science achievement, when instruction and assessment are exclusively or predominantly in a second language (Muzah 2011:76).

The South African situation is no exception to this, as most township secondary schools use English language as the language of instruction for content subjects, including Physical Sciences. While this is true of many science classrooms globally, the situation in South Africa is compounded by the fact that many science classrooms are also multilingual (Msimanga et al. 2017:245).

This situation continues to affect the majority of learners in South African science classrooms, as they only receive their tuition in the second language. The issue of language looms large in South African schooling, given that the majority of children study in a second language, and that language is a crucial vehicle for learning (Umalusi 2005:68). The problem is further compounded by the fact that the words and terminologies that are used during Physical Sciences instruction, and in textbooks and other learning materials, are foreign to the indigenous languages that learners speak, hence they will often struggle to use them in a science context. The second language problem and the teaching of Physical Sciences in a South African context are viewed by (Oyoo 2008:104) as the double task of learning two things at the same time, namely the language of instruction, and science. This poses a challenge as many learners do not cope with the understanding and assimilation of the meanings of words which they only encounter when they are at school. The difficulty experienced by students with language was cited as a reason for their loss of interest in learning science in general, and specifically in reading scientific texts (Seah 2015:10).

Furthermore, this dilemma is compounded by the fact that science teachers, who are key to promoting scientific literacy among learners, are themselves mostly second language speakers, and often struggle to develop their own language skills, together with science content knowledge. However, in order to accomplish this, teachers need to have a strong grasp of the language and how it functions (Hodgson-Drysdale 2014:55). This situation provides even highly motivated learners with authentic reasons for struggling with the comprehension of key concepts that underpin the science curriculum.

2.1.10 Difficulties with non-technical words in a science context

The difficulties associated with the use of non-technical or everyday words in a science context form the basis for this study. The language in which scientific and technical facts are expressed is certainly not a different language from that of everyday life. However, it presents a number of special problems (Narang 2013:232). This effectively suggests that learning in a science classroom can only occur when everyday words or non-technical words are understood and correctly used in a science context.

According to Zisanhi (2013:11) a study done by Maznah and Zurida (2006) in Malaysia established that the majority of learners find the learning of science to be a difficult task, and these difficulties arose not only from the use of symbols to represent concepts, but also the language that must be mastered, particularly the technical and non-technical vocabulary. Other studies, such as Watts and Gilbert (1983), support this finding that scientifically associated words are often poorly understood by first language speakers of English. It is therefore not surprising that second language speakers of English experience great difficulty (Mc Naught 1992:234).

The non-technical or everyday words are considered to be important in studying science in general and Physical Sciences in particular. However, the challenge of these words is demonstrated by the fact that no matter how familiar one is with an English word, it can have a different meaning when used in the science context. The meaning of words when used in a science context confuses learners, who otherwise know their general meaning. Similarity in meaning or sound can cause confusion (Schunk 2004:154). This confirms that there are general contributory factors that are stumbling blocks to the assimilation of this part of the language, as used in the science classroom.

An interesting fact that transpired from the investigation of the use of everyday words in a science context was that the difficulty in comprehending a word seemed to be dependent on a number of factors, such as lack of understanding of the meaning of words, misreading of words, and confusing words (Farrell & Ventura 1998:244). This highlights that the problem lies, not so much in the technical language of science, but in the vocabulary and usage of normal English in a science context (Farrell & Ventura 1998:244). Oyoo (2008:109) sums up these difficulties as confusion stemming from words which are phonetically similar, such as compound for complex; or misreading words, such as contract for constant. However, Donald, Lazarus and Lolwana (2010: 328) state that the most common forms of difficulty are related to comprehending or expressing words. These challenges rob learners of the opportunity to use everyday or non-technical words, and to apply their understanding in a science context.

2.1.11 Implications for science teaching and learning

Although the importance of language in science learning has been widely recognised by researchers, there is limited research on how science teachers perceive the role that language plays in science classrooms (Seah 2015:1). In the majority of science lessons, teachers spend most of their time explaining science concepts and asking questions, in order to test learner's ability to recall definitions and meanings of concepts. Learners often give their responses in words to demonstrate their understanding. On the other hand, teachers are often preoccupied with the correctness of answers given, without determining how the answer was reached, or whether learners understood the meaning of the words. Thus, the approach used by teachers in this instance, does not encourage learners to explore the correctness of their own understanding of the meaning of words in a specific context. Although teachers are keenly aware of how language can be a barrier to the learning of science, they are less certain about what students need to know about the language of science, in order to master it (Seah 2015:1). Students can attain subject-specific knowledge through instruction in their primary language, or through richer and more sustained collaboration between content-area teachers and English language specialists (Banks & McGee-Banks 2013:233).

Furthermore, Oyoo (2010:191) concludes that “especially suggested is the fact that teachers’ approaches to use of language during teaching can potentially impact the levels of students’ understandings of the meanings of everyday words when used in the science context in very important ways”.

The erroneous use of non-technical or everyday words in a science context is often met with negative consequences in a science classroom. When learners encountered certain key everyday words in sentences and explanations, they tended to associate the meaning of the words with their past experiences. As a result, they used meanings derived from other contexts, which resulted in learners incorrectly understanding or interpreting physics concepts (Ncube 2014:87).

In addition, this hampers the general progress in a science classroom, whereby learners fail to make sound connections between words in science vocabulary, as they frequently misinterpret actual meanings of words associated with science concepts. This is often due to the lack of adequate grounding in the use of non-technical words in a science context. The results of such inadequacies are diverse and include poor achievements, even though a learner may be intellectually capable, poor career paths upon leaving school, and lack of acceptable levels of proficiency. Accordingly, Oyoo (2008:118) states that the consequences have been breaks in communication, poor understanding of science concepts, and poor science outcomes. The level of comprehension of the non-technical terms commonly used in science teaching and learning can be improved when English is taught contextually (Zisanhi 2013:12). Strategies such as using as simple a language as possible to express the content, and paraphrasing it in several ways to afford additional referents, were cited as means by which the scientific language could be made more accessible to students (Seah 2015:13). Baker (2011:301) concludes that when new words and new concepts are being introduced into a lesson, the teacher should spend some time in introducing the words and clarifying the concepts, so that the learner is sufficiently prepared.

2.1.12 Summary

This section of the chapter has captured the significance of the meaning of words that constitute a language in promoting the understanding of school science, especially when learners who are meant to be recipients of science education, are themselves second language speakers. The emphasis of this section is therefore on the fact that the basic knowledge of language skills, such as writing, reading and speaking, are a prerequisite for word understanding in the scientific context, thereby promoting the effective study of science. Furthermore, this section explored the difficulties encountered by science learners in understanding words commonly used in a science context. It concluded by discussing the implications of these challenges for the teaching and learning of science in secondary schools. The next section of this chapter focuses on the theoretical models that will guide this study.

2.2 Theories of learning and language acquisition

2.2.1 Introduction

The aim of science is to determine the principles governing the physical universe. However, progress towards this end is to a large extent dependent on language (Crystal 2010:400). Philosophical thinkers around the world, whose main focus is the foundations of knowledge and its linguistical expression, mostly rely on the use of theoretical models to explain the process of learning. In many respects, one can argue that John Locke, an accomplished philosopher, laid the foundation for future thinking regarding the importance of play, language development and learning (Gray & MacBlain 2012:13).

In this section of the chapter, the theoretical framework that underpins the study will be explored, highlighting the language perspectives in teaching and learning, as well as the challenges that inhibit learners' ability to acquire essential vocabulary to support critical thinking. Studies on learning theories suggest that there is a synergic correlation between learners' social environment, cognitive development, and behavioural thoughts, and their language familiarity and articulation. Furthermore, learning theories discusses how language can be used to assist or 'scaffold' learners to mitigate the difficulties that are encountered in the general learning process, in particular science learning. It is reasonable to assume that these theories may influence how learners respond to the various efforts taken to facilitate their science learning (Parsons, Miles & Petersen 2011:257).

2.2.2 Language and learning theories in science

Learning involves the acquisition and modification of knowledge, skills, strategies, beliefs, attitudes, and behaviours (Schunk 2004:1). Learning theories therefore, attempt to organise knowledge on the value of thinking, social interactions, and behavioural patterns, and use that knowledge to provide solutions that will facilitate teaching and learning.

Learning theories are precepts for understanding the processes and experiences of learning which, as explored, have left an important legacy, shaping various facets of educational institutions and practices, and continuing to doing so in overwhelming ways (Mufti & Peace 2012:34).

Language, on the other hand, provides the vehicle for all forms of thought, including reasoning, social development, verbal and non-verbal communication. Communication takes place by means of a verbal and non-verbal interchange of ideas, beliefs, thoughts, feelings and emotions, but most people use speech as a primary way of communicating (Nel, Nel & Hugo 2012:80). Therefore, language and learning theories can be viewed as being in a synergetic and symbiotic relationship in a learning process. They both explain the phenomenon of knowledge acquisition through the use of language, and predict what is possible, and what is not, in the learning process. One may reasonably conclude that as knowledge of the learning process increases, educational practices should become more efficient and effective (Olson & Hergenhahn 2009:288).

Furthermore, learning theories discuss learning problems that exist when learners use their home language to process thinking, and an instructional language to communicate their thoughts. This will help to explain why learners in a science classroom struggle to understand science concepts presented by means of English second language. Thus, the main aim of this study is to identify challenges that exist in relation to language use in the science classroom. In the everyday experience of language, there is a lot of ambiguity in words, and blurred edges between concepts (Kalantzis & Cope 2012:244). Therefore, in the context of using language in a science classroom, learning theories take a centre stage, as they form the basis of how language evolves in general learning, and science learning in particular.

2.2.3 Sociocultural theory and science learning

In sociocultural theory, learning is perceived as a social event taking place as a result of the interaction between the learner and the environment (Fahim & Haghani 2012:694). This view suggests that the social environment of learners, which consist of parents, teachers and peers, serves as a determinant of their scholastic progress and achievement. Before they can become socialised into the discourse practice of the scientific community, students must engage in personal construction and meaning making (Schunk 2004:427).

In light of this, intellectual development cannot be separated from a social context. According to the sociocultural theorist, Vygotsky, human activities take place in cultural settings and cannot be understood apart from these settings (Woolfolk 2010:42). Human thought and development, including language, is dictated by the social world that exists within a particular culture. Language is another cultural tool which, in Vygotsky's view, meditates thinking and learning (Gray & MacBlain 2012:74).

According to Vygotsky, at any given point in a child's development, there are certain problems that the child is on the verge of being able to solve (Woolfolk 2010:47). Therefore, in this context, learners need to be assisted in tasks that are too difficult to master alone. The use of dialogue as a tool for scaffolding is only one example of the important role of language in a child's development (Santrock 2014:186). Vygotsky's concept of Zone of Proximal Development (ZDP) describes the potential of learning as being limited to the unaided level of attainment. Watters and Diezmann (2016:28), state that the ZDP represents the difference between what a student can achieve independently, and what the student can achieve with guidance from a skilled mediator through language. At this level, the knowledge range is difficult for a child to attain unaided. Through guidance and assistance from teachers, other adults and more skilled peers, learners are able to gain an understanding of cognitively challenging knowledge, and to develop more complex skills.

Mufti and Peace (2012:22) are of the opinion that learners must be provided with frameworks and experiences which will encourage them to extend their existing schemata and incorporate new skills, competences and understandings.

Crystal (2010:258) further states that there is a considerable recognition these days of the need to develop a child's linguistic skills, in order to promote their educational growth inside school, as well as social and personal development outside school. Teachers and the significant others in the lives of learners, often use verbal prompts to help learners solve problems and accomplish the tasks at hand. For example, when a physics educator assists a learner in developing an understanding of difficult physics concepts; he/she uses language by scaffolding the learner from a lower level of understanding to a higher level of understanding (Ncube 2014:25).

Accordingly, learners comply by thinking, communicating and performing tasks given in the classroom. Since language plays a central role in cognitive development, it can therefore be viewed as a tool for determining the ways in which a child learns how to think (Ntshangase 2011:4). The sociocultural environment presents learners with a variety of challenges, including language acquisition and mastery. The social approach to education assumes the mediating role of language in our everyday interaction with others (Gülseren 2015:23).

Furthermore, Vygotsky's views on the role of language as a tool for social communication are well documented in his sociocultural theory. During early childhood, children acquire what Vygotsky called spontaneous concepts, in other words, they learn various facts, concepts and rules, such as how to speak their native language and how to classify objects in their environment. However, they do so for the most part as a by-product of other activities, such as engaging in play and communicating with parents and playmates (Snowman & McCown 2013:34). Vygotsky (1986) perceives language development as a process which begins through social contact with others, and then gradually moves inward through a series of transitional stages towards the development of inner speech

(Fahim & Haghani 2012:694). In socio-cultural theory, learners' enhancement of their participation, language expression and articulation is highly significant.

Roth (2014:1054) adds that an important aspect of the continuous development of language as a cultural-historical phenomenon, and the development of individual speech ability, is the uptake of the words and locutions of others for the purpose of developing and supporting the promulgation of our own ideas. This argument suggests that language helps learners to develop cognitive abilities through interaction with the social world. Thus, it becomes essential for the curriculum content in a science classroom to be compatible with learners' levels of proficiency in the language of instruction.

Learners using the second language often face a challenge in articulating the language of instruction, in order to understand the content within their own culture. The words used during instruction and discussions may not be familiar with those of the culture of learners, let alone the context in which they are used. Studying in groups and performing collaborative tasks, such as in a laboratory practice, often afford learners the opportunity to interact with one another and with teachers, in order to overcome this challenge. Integrated science instruction and language development becomes essential in addressing this challenge. Certainly, language provides one of the most powerful semiotic resources, and is central to the enterprise of science learning (Xu & Clarke 2011:502).

2.2.4 Cognitive theory and science learning

Piaget's theory of development is built on evidence obtained from observations of children's spontaneous speech and interactions, as well as from the behaviours observed and explanations offered during spontaneous or constructed problem-solving situations, which reveal the signature characteristics of different stages of development (Fox & Riconscente 2008:373). Learners often use cognition to construct knowledge according to their developmental stages and language abilities. Several studies have been carried out to investigate the link between the stages of cognitive development proposed by Piaget, and the emergence of linguistic skills (Crystal 2010:245). Each stage is characterised by the link that depends on the prior development in cognitive ability. In all stages of cognitive development, language is acquired according to the child's maturity, and occurs throughout their development.

The sensorimotor stage is characterised by the absence of language (Olson & Hergenhahn 2009:288). For example, the first sensorimotor stage is from birth to two years, and refers to an infant's construction of knowledge through sensory and motor skills (Kail & Cavanaugh 2010:14). At this stage, children's language is not developed, as they utter words which do not make sense. In the preoperational stage, children are not able to conceptualise abstractly and have unorganised speech. They talk to themselves, as they cannot internalise and use language to guide behaviour (Ntshangase 2011:4).

According to Evans and Avila (2016:293), in the Concrete Operations stage, as children move along the language development continuum from early childhood to their primary years, they are also beginning to develop essential reading and writing skills. It can thus be argued that learners in this stage can give objects permanent lingual status. In the Formal Operations stage, the child's cognitive structures are well developed, as well as their language. Therefore, the child as a learner is susceptible to developing logic and conceptual growth, and their language use is enhanced. In the same way, the formal operational thinker can understand and use complex language forms, such as proverbs, metaphors, sarcasm and satire (Snowman & McCown 2013:27). Therefore, Piaget's theory suggests that language acquisition and articulation must be viewed within the context of a child's maturity and intellectual development. The content of intelligence comes from the outside, and the coordination that organises it is only made possible through language and symbolic instruments (Olson & Hergenhahn 2009:292).

To further illustrate the innate capacity in children to learn a language, Chomsky argues for a language model called the language acquisition device (LAD). Chomsky's most widely known position is the postulation of a domain specific language acquisition device (LAD) (Behme & Deacon 2008:642). The LAD provides children with knowledge of linguistic universals, such as the existence of word order and word classes. However, other authors suggest that it only provides general procedures for discovering how language is to be learned (Crystal 2010:244).

According to Chomsky, there are highly abstract structures, and highly specific principles of organisation that are characteristic of all human languages, which are intrinsic rather than acquired. They play a central role in the perception and production of sentences, and provide the basis for the creative aspect of language use (Narang 2013:11). In principle, the LAD model can demonstrate the process of acquisition of any natural language (Buhan 2015:195). This principle provides a procedure for discovering how language is to be learned by children. Malone (2012:2) states that children in every language and cultural community learn to understand and speak at a remarkably early age. According to Kalantzis and Cope (2012:203), the basic structures of language, as concluded by Chomsky, must be already present in the brain in a kind of 'language organ' and these are then filled out with specifics of the language or languages to which an infant happens to be exposed. Furthermore, Nkopodi (1998:11) states that common language errors among children which could not be a result of imitating other speakers are then attributed to an undeveloped LAD.

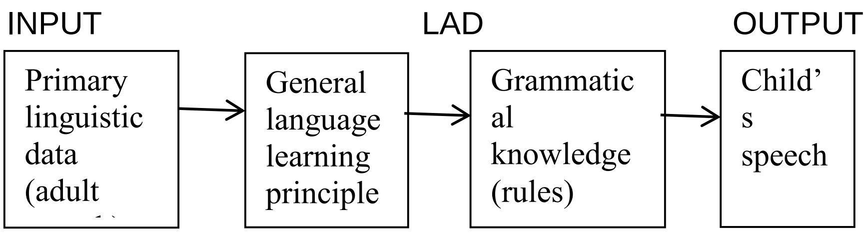


Figure.2.2 Language Acquisition Device (LAD) mechanism
(Source: Cambridge Encyclopaedia of Language, 2010)

As illustrated in Figure. 2.2, the input to language development in a school context starts in primary school, where learners experience different linguistic settings in which levels of formal and informal conversations are distinguished. Learners at this level are grounded in their home language and their conversation is largely informal, based on their daily experiences, and they rely mostly on their teachers for further language development. Classroom lessons that involve second language and words used in conversations assume a definite order. As children expand their vocabulary, they begin to construct syntactically complex multiword utterances (Behme & Deacon 2008:651).

To acquire the LAD, they learn word orders such as nouns, pronouns, adjectives, verbs, prepositions, conjunctions, adverbs and interjections.

These words are used in their easiest form in a written language, according to their cognitive ability, culminating in formal speech, which forms the output of their language use and articulation. Chomsky argues that when growing up, the examples of language use that children get from adults could amount to sufficiently coherent and systematic data set from which children could become skilled language users (Munroe & Cangelosi 2003:312).

At secondary school level, which is of direct relevance to this study, the instructional language, which is the English second language, is dominant in most of the subjects that are taught. The correctness of language use and its application is emphasised, in order to meet the learning demands of content subjects. In a science classroom, the language of science becomes crucial. It is at this stage that learners are gradually introduced to texts and classroom language which is aimed at enhancing their science vocabulary. However, the challenge of language skills at this level turns out to be a cause for concern, as learners find it difficult to cope with language use in a science context. Learners at this level find it difficult to match their cognitive abilities with the language of instruction, in which they have limited proficiency. Furthermore, learners in a science class often grapple with understanding the meanings of words presented in their textbooks and other written materials, such as laboratory manuals and study guides. The teacher's use of language is a further stumbling block in mitigating the challenge of familiarising learners with words normally used in science contexts. In a science classroom, learners should therefore be assisted to identify as many words as possible in their texts and materials, and to apply their meanings when learning about scientific concepts. Therefore, learners' cognitive abilities, coupled with their familiarity with the meaning of such words, will eventually lead to the building of vocabulary.

2.2.5 Constructivism and science learning

Constructivism theory is a shared theory grounded in research conducted by Piaget, Vygotsky, Gestalt psychologists Wertheimer, Koffka, and Köhler, and the philosophical work of John Dewey; It can therefore be said to have an interdisciplinary perspective, unlike the psychological, sociological, philosophical and critical educational theories (Ültanir 2012:199). Constructivism theory is thus a model of learning based on the premise that knowledge is constructed from personal experiences and understanding. In other words, meaningful learning is the active creation of knowledge structures (such as concepts, rules, hypotheses and associations) from personal experience (Snowman & McCown 2013:211).

The core of constructivism is the belief that learning is an active process in which learners construct new ideas and knowledge based upon their current and past experiences (Hlabane 2014:39). According to this theory, learners are empowered to construct their own understanding, in order to make sense of learning experiences. Gray and MacBlain (2012:70) state that in social constructivist theory, it is important to consider the quality and nature of the child's environment, age, culture and life experiences, before drawing any conclusions about their development. Understanding that students construct meaning has led to an increased focus on students' interpretations of what they witness in class (Wilson & Peterson 2006:3). In accordance with this theory, educators use language to create connections between facts, and to foster new understanding in learners.

While there is a general consensus among educators that the learning process ought to focus more on primary concepts, extensive dialogue using language must also be promoted in classrooms. Consequently, if a learner does not have adequate language skills or experiences language problems, this may cause learning problems (Nel et al. 2012:80). It is important that learners should reach out to embrace learning through the language of instruction, given the power of expression that it provides in constructing meaning.

The science classroom provides a unique opportunity for constructivist teachers to encourage learners to analyse, interpret and predict information through dialogue, which will assist them to judge their own progress. In settings such as a laboratory, learners are encouraged through collaboration with others to invent projects, and perform experiments based on existing knowledge from textbooks, audio and video materials, and other personal experiences in learning.

According to this perspective, in order to predict how learners will respond to attempts to teach science, it is necessary to understand the knowledge that students bring to a given teaching situation (Leach & Scott 2003:92).

The constructivist approach to teaching promotes words that we hear and use in our everyday lives, in order to foster the construction of new understandings. Thus, learners learn by thinking about and trying to make sense of what they see, feel, and hear all around them (Hlabane 2014:39). Furthermore, learners begin to take responsibility for their own work, and thus become problem solvers. Learners in a science classroom tend to construct or invent their own meaning of words, which alters intended outcomes. These misgivings lead to errors and misconceptions about the correct use of words in the learning of science. Errors and misconceptions often arise during classroom instruction, interaction with texts from learning materials, and from other learning resources at their disposal. This situation creates learning difficulties and misunderstandings in science instruction, because learners are unable to combine science content and language.

The constructivist approach to science learning will encourage the construction of scientific knowledge that is supported by adequate comprehension and application of specialised words in science contexts. Cooperative learning in a science classroom, spearheaded by accuracy in the choice of words used, can lead to a deeper understanding of scientific concepts. Thus, learners may derive pleasure and satisfaction from being given a space to test their understanding of scientific phenomena and their applications.

2.2.6 Behaviourism and science learning

Pritchard (2009:2) is of the opinion that learning is a “process by which behaviour is changed, shaped and controlled”. The behaviourism theory thus focuses on changes in observable human behaviour and processes that are involved in the acquisition of knowledge. According to Ahmad (2012:201), learning in any shape or form is always associated with changes in learner’s behaviour. In behaviourist approaches to teaching, strategies adopted by teachers are generally whole-class focused, with knowledge being transmitted where students are generally passive recipients of information, and where talk is dominated by teachers (Watters & Diezmann 2016:28). Thus, the process whereby we acquire knowledge through the use of language is very similar to the process in which we learn new concepts. The behavioural view generally assumes that the outcome of learning is the change in behaviour, and it emphasises the effects of external events on the individual (Woolfolk 2010:198). According to this theory, learning is equated with acquiring a new conditioning behaviour. Skinner (1957) argued that humans acquire responses, including language, according to the laws of operant conditioning (Klein 2012a:341).

Therefore, conditioning and behavioural change are important principles of learning in relation to the behavioural theory. Skinner, an accomplished scholar of behaviourism, was of the opinion that behavioural change results from conditioned learning. He believed that behavioural change is learning (Edgar 2012:3). Furthermore, according to behaviourists, the important process governing our behaviour is learning (Klein 2012b:3). The learning principles entail subjecting oneself to learning objectives continuously, and achieving the desired results from that activity.

Skinner believed that verbal behaviour (language) can also be explained within the context of reinforcement theory (Olson & Hergenhahn 2009:103). Learners in a science classroom are often conditioned to view reading as an important learning strategy. They engage in preparatory reading for forthcoming lessons, tests and tasks that must be performed to reinforce their understanding. Given such an opportunity to read study notes, texts, and manuals, and to verbally expressing their thoughts, learners subject themselves to behavioural change. This is demonstrated by their ability to perform better in tasks that require prior prepared reading, incorporating the use of language. When learners have to read, they have time to think about the meanings of the language (Nel et al 2012:97). Language comprehension tasks that will encourage learners to read can be designed for every lesson topic (Hlabane 2014:35).

The science classroom is characterised by overwhelming behaviourism, where learners consciously or subconsciously engage in imitating the tasks presented by the teachers during class demonstrations and other learning activities.
They follow the instructions of the teacher by copying notes, referring to texts, identifying different words and their meanings, and performing other tasks as requested. Furthermore, they are continuously assessed on the quality of their work, and rewarded through praise. This is done through an element of behaviourism called reinforcement, which can facilitate science classroom communication through the use of language, by rewarding positive behavioural practices such as good verbal and written presentation of a science project, and discouraging slovenly and mediocre performance. Skinner (1957), argues that it is exactly through this form of shaping that we learn a complex skill such as language, in which informal reinforcements from parents and teachers (such as attention and praise) shape babbling and cooing into verbalisations akin to everyday language (Mufti & Peace 2012:11).

2.2.7 Theories of second language learning

The theories of second language learning are founded on the notion of how language is acquired. There are several theories of second language learning which include Vygotsky's theories on language and thinking (Hlabane 2014:41). The dominant theory, which still retains considerable influence, is the Monitor Theory developed by Stephen Krashen (Van Patten & Williams 2007:17). Krashen's model is based on five hypotheses, namely the Acquisition-Learning Hypothesis, Monitor Hypothesis, Natural Order Hypothesis, Input Hypothesis and

Affective Filter Hypothesis (Kumar & Nazneen 2016:218). These hypotheses have not only survived well over the years, but have also proven to be useful in other areas of language education (Krashen 1989: vii).

2.3 Theoretical framework

For the purpose of this study, the focus will be on the Input Hypothesis and the Affective Filter Hypothesis, in order to provide a theoretical framework, because these two hypotheses are mainly concerned with the classroom instruction of second language speakers. The input hypothesis states that in order for language acquisition to take place, the acquirer must receive comprehensible input through reading or hearing language structures that slightly exceed their current ability (Krashen, 1989:441). This notion effectively suggests that learners, who are exposed to comprehensive learning input, where that input is well understood, will automatically acquire the language. The input hypothesis theory has provided a significant set of guidelines for creating optimal language-learning environments (Banks & McGee-Banks 2013:232). This is also applicable to a second language science classroom, as most learners engage in frequent verbal communication with fellow learners and teachers about scientific concepts. Learners who frequently and painstakingly peruse science content reading materials are bound to be exposed to more science words, thereby expanding their science vocabulary.

This effort further ensures progress in the expansion of knowledge of science concepts, coupled with the comprehension language input that is within the level of their language proficiency. Learners who are taught in a second language lack language skills to cope with the large vocabulary encountered during science classroom interaction. Thus, their input ability suffers as they struggle to cope with a large amount of words intended to be used in their context of learning. As Krashen (1989) further states, since second language learners acquire language in a predictable natural order, it would be relatively easy for second language teachers to detect the level of competence of learners and design teaching material accordingly (Zafar 2010:141).

The Affective Filter Hypothesis on the other hand, states that various mental states of learners such as emotions, attitudes and motivation, which discourage learning even though a learner is exposed to a large amount of comprehensible data, are referred to as an affective filter (Kumar & Nazneen 2016:223). These mental states interfere with the process of acquiring the language necessary to excel in science learning. For example, a tired or bored learner may not register any aspect of language, although exposed to comprehensible language (Kumar & Nazneen 2016:223).

According to this hypothesis, learners who have a positive attitude towards language learning are often comfortable accessing a comprehensible amount of input, and have their filters set low to sift through the vast amount of available knowledge. This hypothesis has far reaching implications in a science classroom, as learners receive a massive amount of scientific concepts through communicating, reading and writing different types of science texts. They continuously sift by identifying, selecting, and expressing important and relevant information for their studies. This encourages and assists learners to comprehend important words necessary for effective science learning. Learners in this sphere of knowledge acquisition are often comfortable with learning new science concepts and improving on them. The filtering level of information for most township secondary school learners is mostly low, as the majority of them suffer from low self-esteem and self-motivation, due to their low socio-economic background and emotional instability. For instance, Krashen claims that a total absence of filter, even in children, can be affected by personal variables such as feelings of insecurity, anxiety and lack of self-confidence, factors which are known to stand in the way of some learners' language acquisition (Zafar 2010:144).

2.4 Summary

In this section of the chapter, different theories of learning have been discussed, including the theoretical framework guiding the study. The theories of learning related to the social environment, cognitive development, behavioural thoughts and language development challenges, particularly in a science classroom. The influences of learning theories have demonstrated the holistic development of learners in science classroom communication through the language of instruction, and have provided suggestions on how learners can be assisted to achieve their full potential. The next chapter describes the research methodology adopted for this study. Also included are the issues around ethical considerations and informed consent.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Kothari (2004:8) defines research methodology as a way to systematically solve the research problem, and it may be understood as the science of studying how research is done. As discussed in chapter one, this study is aimed at investigating the challenges encountered by Physical Sciences learners in understanding the meanings of words in the science context. The focus in this chapter is on the research methodology used to explore the difficulties in understanding the meanings of words in a science context. This includes discussions on the research design, which describe the details of the participants, instruments used, sources of data, and procedures for data collection and analysis**.** The chapter also explains how the pilot study was conducted, in order to identify any challenges that may exist in the execution of the research project. Finally, the ethical considerations, as well as the validity and reliability of the instruments, are discussed.

3.2 Research design

According to McMillan and Schumacher (2014:28), the purpose of a research design is to specify a plan for generating empirical evidence that will be used to answer the research questions. Bertram and Christiansen (2014:40) state that the research design is essentially a plan of how the researcher will systematically collect and analyse data that is needed to answer the research questions. Punch and Oancea (2014:144) add that the design sits between the research questions and the data, showing how the research questions will be connected to the data, and what tools and procedures will be used in answering them. Furthermore, Yin (2003) explains that a research design is preferred when the researcher is trying to address descriptive (how) and/or explanatory (why) questions, and desires to produce a direct understanding of the people and events being studied (Alegria 2013:106). In any given scientific research project, one research method may best describe the overall project (Marder 2011:15).

In this study, the researcher used a survey as the overall research approach, because information collected from a survey represents a much broader picture, of the population, and can produce patterns when analysed. A survey requires research tools such as questionnaires, interviews or observations (Mifsud & Farrugia 2017:89). The method of collecting and analysing data in this study was a mixed method, which incorporates both quantitative and qualitative methods. According to Newby (2014:135), one combines these two methods in order to reflect dimensions and nuances in the research topic. The quantitative method used the questionnaire as an instrument, while the qualitative method used semi-structured interviews as an instrument.

3.2.1 Qualitative research design

Qualitative research deals mostly with the processes that drive behaviour and the experiences of life (Newby 2014:96). In this study, the qualitative aspect was informed by the researcher's desire to establish an understanding of the depth and extent of the difficulties experienced by learners with the meaning of words, when used in a science context. According to Hlabane (2014:47), this is only possible if the researcher utilises qualitative methods, in order to better understand the situation. This methodological approach allowed the researcher to conduct an in-depth exploration of learners' experiences and challenges in terms of understanding words in a specific context.

Since the primary aim of this study is to investigate learners' difficulties in understanding the meaning of words in a science context, the researcher was able to extract the in-depth views of participants using a qualitative approach. Check and Schutt (2012:247) are of the opinion that qualitative methods presume an intensive measurement approach in which indicators of concepts are drawn from direct observation or in-depth commentary. Through face-to-face interviews, the researcher was able to extract the views of all participants in this study, and used a tape recorder to capture their views. Oliveira and Brown (2016:744) conclude that, in line with the exploratory goal of achieving a more sophisticated understanding of a real-life phenomenon, a qualitative methodology that favours analytical depth over breadth is preferred.

3.2.2 Quantitative research design

Quantitative researchers collect facts and study the relationship between two sets of facts (Bell & Waters 2014:281). The quantitative analysis approach used in this study attempted to provide a numerical explanation of the difficulties experienced by learners with the meaning of words, when used in a science context, through the use of statistical techniques to analyse the collected data. For example, standardised questionnaires and other quantitative measurement tools are often used to carefully measure what is observed (Johnson & Christensen 2014:36). Setati (2011) in Hlabane (2014:47) states that in the past, behavioural sciences conformed to the scientific epistemology, which advocated that any phenomenon could be described and reduced to its statistical or numerical elements, and then collated and attributed to causal powers.

In this study, a quantitative design became necessary in order to gain better understanding of the depth of the problem encountered by Physical Sciences learners in assigning meanings to words in a science context, as referred to in the aim of the research. Therefore, data gathered using the questionnaire was converted into tables and graphs, in order to summaries the results for statistical analysis and interpretation. The data was subjected to statistical analysis, using techniques that are likely to produce quantified and, where possible, generalisable conclusions (Bell & Waters 2014:281).

3.2.3 Multiple method research design

Cohen, Manion and Morrison (2011:25) maintain that the multiple method approach addresses both the 'what' (quantitative) and 'how or why' (qualitative) types of research questions. This assertion is particularly significant if research is intended to offer different explanations for the outcomes. The use of questionnaires helps to obtain written information, while interviews helped the researcher to get in-depth understanding of quantitative data obtained. However, a multiple method approach also has disadvantages. For instance; it requires extensive data collection and more resources than other methods (Semeon 2014:23).

3.3 Data sources

The four selected schools were used as research sites for the study. The learner and teacher participants were sourced through a formal request and other ethical considerations, which are discussed later in this chapter. The criterion for selecting schools was based on the schools' accessibility, availability and provision of Physical Sciences as a learning area.

As illustrated in Figure 3.1 below, only learners were asked to respond to questionnaire, whereas the interviews were conducted with both learners and teachers.

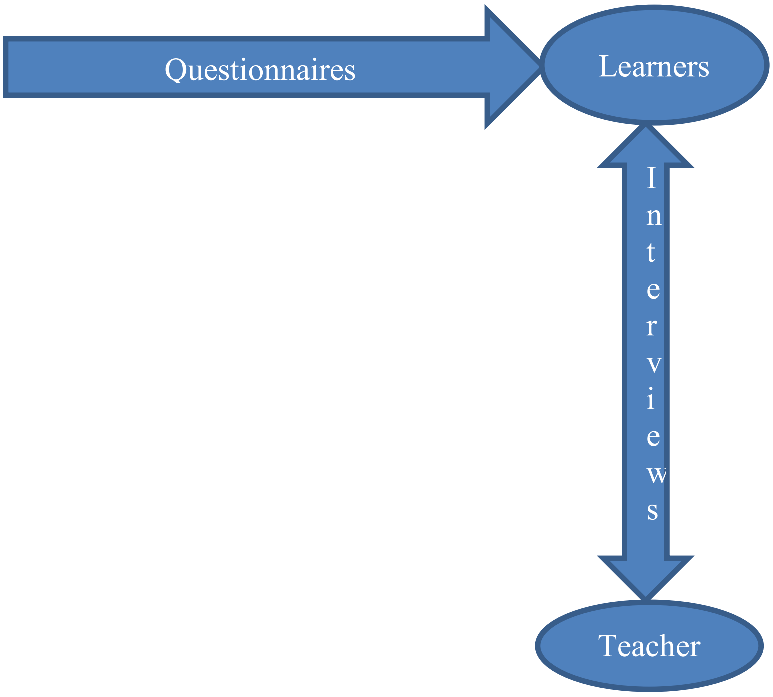


Figure 3.1: Data collection strategy

The questionnaires were used for selecting appropriate responses from the choices of answers provided, while interviews transcripts were used for verbatim translation of recorded verbal data.

3.3.1 The Questionnaire

According to Mc Millan and Schumacher (2014:476), a questionnaire is a written set of questions or statements that is used to assess attitudes, opinions, beliefs, and biographical information. The use of a questionnaire was considered to be appropriate for this study because it would enable the researcher to obtain numeric data to be statistically analysed, in order to meet the objectives of the study (Oyoo 2011:852). For the purpose of this study, a valid and reliable questionnaire was considered to be essential for achieving the objectives of the study i.e. provide answers to research questions. The researcher selected a close-ended questionnaire (multiple choice type questions) because it had predetermined answers that would help the researcher to extract participants' understanding of the use of English language words in a science context. In this way, the researcher was able to demarcate the research parameters, as the choice of responses was limited.

The questionnaire (Appendix F1) used in this study was adapted from previous research studies conducted by Oyoo (2004) in Kenyan and UK schools (Oyoo & Semeon 2015:52). Furthermore, Oyoo and Semeon (2015:52) maintain that it is possible to use the adapted questionnaire, without it being piloted. This was because it had been tested for validity and reliability prior to its use in the study. The adaptation was necessary because the researcher wanted to focus on Physical Sciences questions, as this learning area was the focus of this study. McMillan and Schumacher (2014:211) substantiate this, by stating that in many cases, existing instruments can be used or adapted for use, instead of designing a new one.

Other information contained in the questionnaire included code name, grade, gender, age, language of instruction, home language, whether assistance was received with homework, and the economic status of parents, in other words, whether they were employed and/or skilled, or unemployed and/or unskilled. The rest of the questionnaire consisted of multiple choice questions. In the multiple choice questions, learners were expected to choose one correct option from the four provided. They had to indicate their preferred answer by circling the option that they chose. These questions were aimed at determining their understanding of English language words when used in a science context.

Below is an example of a question asked in the questionnaire in relation to the word 'displaces', which appears as question no. 2 in the questionnaire.
2. When the stone is lowered into a beaker of water, it displaces some of the water. This means it…

A. Reacts with some of the water
B. Simply falls through the water to the bottom of the beaker
C. Gets bigger
D. Pushes away some of the water

The answers given by participants were important because they provided the researcher with the basis for determining whether the participants understood the meaning of these words when they were used in the science context.

3.3.2 The Interview

According to McMillan and Schumacher (2014:221), an interview involves direct interaction between individuals. A written request was sought from learners and their parents to consent for an interview. The face-to-face interview method was considered to be an important tool to uncover knowledge about the depth of challenges that learners experience in terms of understanding words used in science learning. The focus group interview, which is semi-structured, was considered to be essential for this study, because it allowed for flexibility in responding to questions posed in the questionnaire. A semi-structured interview was used in this study because it is flexible; allowing new questions to emerge during the interview as a result of what the interviewee says (Dhurumraj 2013:28). Furthermore, Oliveira and Brown (2016:745) state that a semi-structured interview affords the researcher an opportunity to probe further into the interviewees' experiences, by posing clarification questions and asking them to elaborate on the reasons for their written responses.

In some circumstances, researchers choose to record their interviews via audio or video technology for later transcription (Mertens 2010:372). An audiotaped semi-structured interview was used in this study, in order to allow participants to elaborate on their responses in the questionnaire in relation to the meaning of English language words when used in a science context. Thus, the purpose of the semi-structured interview was to allow the researcher to probe where necessary. In addition, the interview was aimed at validating the questionnaire responses given by participants. The researcher used the interview schedules (Appendices D and E) to transcribe verbatim responses given by participants. The interview schedule was designed with questions in a sequence, which allowed the researcher to extract as much verbal data as possible. Audiotaping the interviews helped the researcher to capture verbatim responses given by participants on their understanding of English language words when used in a science context.

3.4 Study Context, Sampling and Details of Participants

3.4.1 Research site and details of participants

The research project was conducted at four designated township secondary schools in the Gauteng East District over a period of four weeks. The participants were Grade 11 Physical Sciences learners (Table 3.2) and their respective Physical Sciences teachers (Table 3.1).

Table 3.1: Summary of details of participating teachers

Teacher	School	Home language	Highest science qualification	Teaching experience (years)
Mr. P	W	Sepedi	BSc (Education)	5
Ms. K	X	IsiXhosa	STD, B.Ed Hons	19
Ms. P	Y	Sesotho	STD, B.Ed Hons	21
Ms. M	Z	IsiZulu	BSc, PGCE	3

Table 3.2: Summary of details of participating learners and their home languages

Sch	Boys	Girls	Sepedi HL	Setswana HL	IsiZulu HL	IsiXhosa HL	Sesotho HL	Xitsonga HL	Tshivend a HL	SiSwati HL	IsiNdebele HL
W	19	21	---	---	24	1	12	1	1	1	2
X	16	10	1	2	16	---	4	---	---	1	---
Y	14	20	1	---	27	---	6	---	---	---	---
Z	15	20	1	---	17	12	2	---	---	---	2
Tot	64	71	3	2	84	13	24	1	1	1	4

- **Pseudonyms for schools and teachers' names were used for ethical reasons.**

3.4.2 The four participating schools

The Gauteng East District is one of fifteen districts in the Gauteng province. It consists of 53 secondary schools, of which 38 are in the townships. The district also consists of four towns, namely Benoni, Brakpan, Nigel and Springs. The research project was conducted in four secondary schools located in these towns' respective townships, namely Daveyton (school W), Tsakane (school X), Duduza (school Y) and Kwa-Thema (school Z). The four schools are mixed gender schools, with a homogeneous race, and their populations are around 1 600, 1 500, 1 360 and 1 098 respectively. The average age of learners participating in the study in all four schools is 17 years.

The schools' teaching programme starts at 7.30 in the morning and ends at 14.30 in the afternoon with the first period commencing at 8.00. The first thirty minutes before the first period is spent in the assembly for religious devotion. Each lesson lasts for thirty minutes and most periods are doubled in the time table, in order to increase the contact time.

The learner participants in four schools were from diverse linguistic background as shown in table 3.3. All participating learners took African languages as first languages in their curriculum package, except for Tshivenda, SiSwati and IsiNdebele, which are not offered in Gauteng East secondary schools.

Table 3.3: Home language composition of participating learners.

School	Sepedi	Setswana	IsiZulu	IsiXhosa	Sesotho	Xitsonga	Tshivenda	SiSwati	IsiNdebele
W	---	---	24	1	12	1	1	1	2
X	1	2	16	---	4	---	---	1	---
Y	1	---	27	---	6	---	---	---	---
Z	1	---	17	12	2	---	---	---	2

The four participating science teachers were three females (in schools X, Y and Z), whose home languages were IsiXhosa, Sesotho and isiZulu respectively and one male (in school W), who had a Sepedi language background (see Table 3.1). Their qualifications were in science and mathematics education (Table 3.1). All the learner and teacher participants used English language as the language of teaching and learning in their respective schools.

3.4.3 Sampling

Lodico, Spaulding and Voegtle (2010:214) state that the most important aspect of sampling is that the sample must represent the larger population from which it is drawn. Wilson (2013:88) further states that before starting to collect data for all methodological approaches, one should define the population of one's area of interest, and determine the size of the sample by using an appropriate sampling strategy. The convenience sampling strategy was considered relevant to this study because all participants in a classroom were accessible for collection of data.

The sample of this study was drawn from all Grade 11 Physical Sciences learners and their respective teachers in the four participating schools. The schools were selected based on their accessibility, availability and provision of Physical Sciences as a subject. A total of 138 learners participated in the study. There were 71 female learners, 64 male learners, and three learners (who did not indicate their gender). There were a total of four teachers (three females and one male). According to Mc Millan and Schumacher (2014:154), the general rule in quantitative research is to obtain as many subjects as needed or possible, in order to obtain credible results. However, there are often constraints to the number of participants, such as financial or logistical, or due to their lack of availability. Learners in the sampling frame were mostly 18 years and younger (see appendices H1-H4).

3.5 Actual Data Collection

3.5.1 Access to the research site

Klein (2012b:24) indicates that informal access refers to the ability to not only enter a research setting by obtaining permission, but to develop positive interaction with participants in that setting. In all participating secondary schools, permission was initially sought from Grade 11 Physical Sciences teachers, whom the researcher had earlier approached and briefed about the research project. In turn, these teachers introduced the researcher to their principals, who cooperated and willingly accepted the letter requesting permission to conduct this research.
The Physical Sciences teachers were issued with request letters and further requested to sign the consent forms (Appendix A3) for the interview, which would take place once the questionnaire had been completed and the learner interview had taken place. The principals also acknowledged the letter (Appendix A2), thereby granting permission for the use of the schools and Grade 11 participants.

An appointment was scheduled for the researcher to meet the Grade 11 participants, in order to explain the objectives of the research and their rights to participation, before they were issued with letters requesting their participation in the study, as well as the signing of consent forms (Appendix A6). They were informed that they needed to participate willingly, and that their parents or guardians had to agree to their participation by also signing consent forms (Appendix A5).

3.5.2 Data collection procedure

Punch and Oancea (2014:376) define the data collection procedure as the procedures for collecting data, such as the administration or use of research instruments, the interaction with participants before and after data collection, the use of technology, and modes of recording information. The data collection process took place during the afternoon when the formal school programme was not operational, and prior arrangement with teachers was made in this regard.

3.5.3 Questionnaire procedure

The questionnaires were delivered on site and administered formally in the classroom by the researcher, who was assisted by a teacher. The learners were seated at a reasonable distance from each other, in order to avoid contact and communication. The researcher distributed questionnaires to the participants and then explained how the questionnaires were to be filled in. Furthermore, the researcher indicated that they were free to ask questions if anything was not clear in terms of the questionnaire. In addition, participants were told not to write their names and those of their schools or institutions anywhere in the questionnaire. Instead, codes were used to replace names, in order to ensure the anonymity and confidentiality of participants.

The participants were also requested to fill in other information, as required in the questionnaire. The researcher advised participants to read and understand the questions before attempting to respond. Participants were expected to respond to questions by circling one of the four options provided, and were not allowed to share ideas on filling in the questionnaire. They had to submit the questionnaire to the researcher on completion. The duration for completing the questionnaire was 30 minutes, in order to ensure that participants answered all questions. The majority of participants completed the questionnaire within the stipulated time frame of 30 minutes. Once the session had ended, the participants were allowed to leave the room and take a break of about 30 minutes, in order to allow the researcher to have time to mark their responses. At a later stage, participants were called and willing learners volunteered to avail themselves to form focus groups, in order to discuss their responses in an interview form.

3.5.4 Challenges with questionnaire data analysis

The researcher had initially numbered and prepared code names in the questionnaire, based on the number of learners who submitted forms from themselves and their parents. Some learners from school W withdrew their participation after the questionnaires were already issued to them, citing challenges such as transport leaving them behind, pending appointments with parents, fetching a sibling from day-care, not feeling well, etc. As a result of their withdrawal, their questionnaires had insufficient data, hence the learner codes appearing on the graph were not arranged in a sequential order. In school W, the learners who withdrew their participation were the following: W_9, W_{10}, W_{43}, W_{44}, W_{45}, W_{46} and W_{47}. The other schools, namely X, Y and Z had no withdrawals.

3.5.5 Interview procedure

The focus interview was conducted at all participating schools with Grade 11 Physical Sciences learners. A group of 10 participants in school W, 9 in school X, 11 in school Y and 12 in school Z, volunteered to be part of the focus group interview. The participants were required to respond to answers given in the questionnaires.

The questions asked in the interviews were based on the two different words in school W (spontaneous & factors), and school X (valid & retard), and three different words in school Y (contract, convention & displaces), and school Z (prepare, effect & disintegrate), which had overwhelmingly low percentage of correct responses (see Table 4.1). The researcher requested participants to elaborate on some of the responses they had given as answers in the questionnaires. An audiotape recorder was used to capture the responses of the focus groups to the interview items. Interview questions were drawn from a designed interview schedule for learners (Appendix D). The interview questions ranged from familiarity with the word and frequency of the word usage to the association with a particular Physical Sciences topic or lesson.

Three examples of questions from the interview schedule are provided below;

1. In the questionnaire, the word ‘spontaneous’ was used to explain a science phenomenon. Is the word familiar to you?
2. What is the reason for your choice for the meaning of the word ….?
3. Did you come across this word in a Physical Sciences lesson?

The explanations given by participants were important because they provided the researcher with the basis for determining whether the participants understood the meaning of these words when they were used in the science context.

3.5.6 Teacher interview procedure

After interviewing the participants, the researcher requested an interview with the teachers of the four participating schools. The brief interviews were held at different venues in the schools, such as departmental offices and laboratory cubicles. The teachers were requested to comment on the learner participants’ responses in the questionnaires, which participants had mostly answered incorrectly. The purpose of the interview questions in the schedule was also to ask the teacher to provide reasons for participants’ response choices, as well as to identify other external influences on their choices. The audiotape recorder and interview schedule (see Appendix E) were used to capture the responses given by the teachers.

In particular, the audiotape recorder was used to help the researcher to capture verbatim responses given by the teachers regarding the learner participants’ understanding of everyday words when used in a science context. The interview schedule enabled the researcher to transcribe the teachers’ responses in relation to the participants’ understanding of non-technical words when used in a science context.
Examples of questions in the teacher interview schedule which the teachers were expected to answer included the following:

1. The learner gave a particular meaning of word …………………………….. as an answer. Do you remember using this word …….. in your lesson?
2. Which topic were you teaching?
3. Do you think that learners have the same understanding as you?

3.5.7 Research ethics

According to McMillan and Schumacher (2014:129), ethics are generally considered to deal with beliefs about what is right or wrong, proper or improper, and good or bad. Cohen et al (2011:77) further explain that much social research necessitates obtaining the consent and cooperation of the participants who are going to assist in the investigations. Muzah (2011:118), identifies the following ethical issues which researchers should take into consideration: informed consent, avoidance of harm, violation of privacy, anonymity and confidentiality, deceit of respondents, respect for human dignity, which encompasses the right to full disclosure, and debriefing of respondents, which anyone who is involved in research needs to be aware of.

For the purpose of this study, permission to conduct research was sought from the Gauteng Department of Education, through the district office under whose jurisdiction the schools fall. Permission was also sought from the participating schools' principals, Physical Sciences educators, Physical Sciences learners, and their parents. Consent forms were issued to all stakeholders including parents and learners under consent age, which guaranteed their anonymity, confidentiality, voluntary participation, and the right to withdraw from the study at any stage.

3.6 Design of the Questionnaire

3.6.1 Issues of reliability and validity

According to Bell and Waters (2014:120), regardless of the procedure used for collecting data, it should always be examined critically to assess to what extent it is likely to be reliable and valid. Validity and reliability are key concepts in any form of enquiry (Setati 2011:116). The instruments used in this study, namely the questionnaire and interview, were tested for reliability and validity through a pilot study at school level. Since the questionnaire used in this study was adapted from previous study, it had established validity and reliability. The interview questions in the interview schedule were consistent to ensure that all participants were asked standard questions. It is also important to consider reliability, which refers to the consistency and repeatability of data collected over time, across different samples, and across different measures of the same underlying construct (Wilson 2013:173). According to Oliveira and Brown (2016:748), consistency of patterns across data sources is considered to be indicative of analytical validity.

3.6.2 Pilot study

According to Bell and Waters (2014:167), all data gathering instruments should be piloted to test how long it takes recipients to complete them, as well as to check that all questions and instructions are clear, and to enable the researcher to remove any items that do not yield usable data. The pilot study was conducted at the school of the researcher with about 24 Grade 11 Physical Sciences learners, in order to determine the general challenges that they experienced with the instruments, and to test the efficacy of the instruments used. The participants were asked to go through the questionnaire and check whether they understood the phrasing of the questions. They were encouraged to report any errors and omissions that they detected in the questionnaire. In this regard, one learner identified the word 'convention' in question no. 19, which was not underlined as expected.

There were no other significant errors and omissions detected in the questionnaire, although some learners asked for clarification in terms of some of the questions. The questionnaire was further checked by the researcher as an administrator of the interview process, to determine whether there were any errors and ambiguity in the questions, deviant from the original questionnaire, in order to come up with a finally reviewed questionnaire to be used in the study. The audio tape recorder was also tested for its mechanical functionality.

3.7 Data analysis strategy

The researcher was guided by the main research question, namely: What challenges are faced by learner in using everyday English words when learning Physical Sciences in English second language? This enabled him to extract learners' contextual understanding of everyday words in the science classroom, by analysing the questionnaire responses given by both learners and teachers. The completed questionnaires recorded a maximum response rate of 69%, 138 participating learners consented to be part of the research project, out of a target of 200 participants. A memorandum (see Appendix F2) was used for marking the responses given in the questionnaire (Appendix F1).

In scoring the questionnaire, the option deemed appropriate by participants for each item was marked with a tick (✓) if correct, or marked with a cross (x) if incorrect. In cases where two options were selected instead of one, a cross was used to indicate a wrong answer. There was no marks allocated if the question was not answered – instead, the letter 'N' was used to indicate this in the score tables. In the score tables, the correct scores were awarded a tick and the incorrect scores were labelled with a symbol indicating the incorrect choice of answer. Items with the highest correct and incorrect scores were then identified.

Although the study focused on learners' difficulties with everyday words in a science context, the Automated Readability Index was used by the researcher to establish criterion for classifying words as difficult for a learner who is at a particular level in terms of grade and age, based on text comprehensibility. Readability measures are one such tool that authors can use when evaluating text comprehensibility (Crossley, Allen and McNamara 2011:84). According to Begeny and Greene (2013:198), most conventional readability formulas are developed using general assumptions about reading difficulty. Chall and Dale (1995:5) state that most of the classic readability formulas have found that the strongest predictor of overall text difficulty is word difficulty – whether measure as word frequency, familiarity or word length. Furthermore, Crossley et al. (2011:88), using the Coh-Metrix, developed a second language (L2) readability formula that incorporated variables that better reflected the psycholinguistic and cognitive process of reading. In this regard, word frequency provided a variable that was closely aligned to text comprehensibility. According to Crossley, Greenfield and McNamara (2008:475), accurately predicting second language learners' difficulty in reading text is important for educators, publishers, and others, in order to ensure that texts match prospective readers' proficiency levels. The Flesch Reading Ease for Grade 12 English language literature is 56.6% (Chall and Dale 1995:135-140). For example, a reading score of 60-70 is equivalent to a grade level of 8-9, hence a text with this score should be understood by 13-15 year olds (Colmer & Raison 2015:7). This scale suggests that the higher the reading score, the easier the reading for a particular grade level and age. Begeny and Greene (2013:198) add that the purpose of the grade level estimate is to define the difficulty of the text, which means that an average reader in that grade should be able to read or "cope" with the book or passage, without undue frustration.

Based on the findings, the researcher assumed that a word was considered difficult for Grade 11 township secondary school learners, whose ages range from 17-19, if a score of below 60% was achieved in the questionnaire by participating learners. The criterion was extended to include overall achievement in the questionnaire. Furthermore, the criterion was also used because of learners' second language background, general low level of proficiency in the language of instruction, and the fact that they were from township schools.

The researcher further identified words from the questionnaire which were mostly incorrectly scored, in order to make a follow-up during the interview to probe the participating learners regarding their understanding of these words when presented in a science context. The verbatim transcribed audiotaped recordings of interviews with participating learners gave varying opinions on each word which were categorised into types of difficulties. However, not all views were transcribed for the report, because some views were repetitive and lacked coherence. In the teacher interviews, the incorrect words selected by participating learners as answers were considered the most difficult words, and were used to probe teachers regarding the causes of the misunderstanding of the meanings of everyday words in a science context. Through their opinions and explanations, the researcher was able to establish teachers' opinions concerning their awareness of the prevalence of the problem. The teachers, in their own words, admitted that this exercise made them more aware of the existence of such a challenge. Furthermore, they admitted that as second language speakers themselves, they did not pay attention to word usage in the classroom, but focused instead on the assimilation of content, as prescribed by the syllabus.

3.8 Summary

The chapter described the research design, and provided a justification for the choice of data collection methods. This included a description of the participants and the instruments used, namely questionnaires and semi-structured interviews. The method for collecting data ensured that the data was credible. Data collection ended when all the questionnaires were returned and the interview recordings were secured by the researcher. The chapter was concluded by ensuring that the ethical issues were fully addressed by the request letters obtained from all stake-holders, and that the reliability and validity of the data were ensured.

In the next chapter, namely Chapter 4, the researcher will report on the findings of the study, based on the analysis and interpretation of the results obtained from the learners' questionnaire and semi-structured interview, as well as the educators' interview. From these findings, a profile of the challenges related to the use of English language words in a science context will be developed, so that conclusions can be drawn from such findings, and recommendations can be made.

CHAPTER 4

PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the findings that emanate from data collected and analysed quantitatively and qualitatively. Data collected through questionnaires was organised into graphs and tables, while data collected through interviews was recorded verbatim. The analysis of data was done to understand the extent of the challenges encountered by learners in a science classroom in terms of understanding the meaning of everyday words when used in a science context with specific reference to the four participating schools in the Gauteng East District. In concluding the chapter, the researcher compared the findings on common trends in challenges faced by the learners of the four participating schools, in order to get a clear picture of the magnitude of the challenge of using everyday words in learning Physical Sciences.

4.2 Data analysis and interpretation

According to McMillan and Schumacher (2014:486), it is almost impossible to interpret data, unless it is organised. Data analysis was used to interpret data generated from the questionnaire and interviews to arrive at meaningful interpretations and conclusions. In this study, data collected through questionnaires was analysed using a marking memorandum to allocate marks, and organised into tables and graphs, while data collected through interviews was transcribed in an interview schedule for entry into a database and categorised according to participants views, patterns in answering questions and general understanding of everyday words used in a science classrooms. This was done to provide a broad picture of the extent to which Grade 11 learners in township secondary schools in the Gauteng East District encounter challenges with the language used in the science context. Thus, the analysed data enabled the researcher to answer the research question. The patterns produced by the analysis were necessary to make a meaningful interpretation of the results, and in order to draw conclusions based on the findings of this study.

4.3 QUESTIONNAIRE RESULTS

The questionnaire comprised of 25 questions which learners answered. A pre-developed memorandum was used to mark the questions. The marks obtained by each learner were converted into percentages. The percentage for each learner was then transferred to tables in appendices G1 to G4. The learners' names were coded with the symbols of their schools, for example, the letter "W" represented school W, and a number next to letter "W" was used to identify the learner e.g. W1, W2…..

4.3.1 Questionnaire results: School W (N=43)

The overall performance of the learners from school W is indicated in Appendix G1, with a mean score of 47.2%. Fig. 4.1 below illustrates the performance of learners from school W. The highest score of 80% (n=1) indicated that none of the participating learners knew all the meanings of everyday words when used in a science context.

As Fig. 4.1 further indicates, the lowest score of 28% (n=2) indicated that although all learners were familiar with some everyday words, their ability to use them in a science context varied and was limited. Only 30% (13/43) of learners scored 60% and above. Therefore, the overall scores suggest that the majority of learners in School W experienced the challenge of understanding the meanings of everyday words when used in a science context.

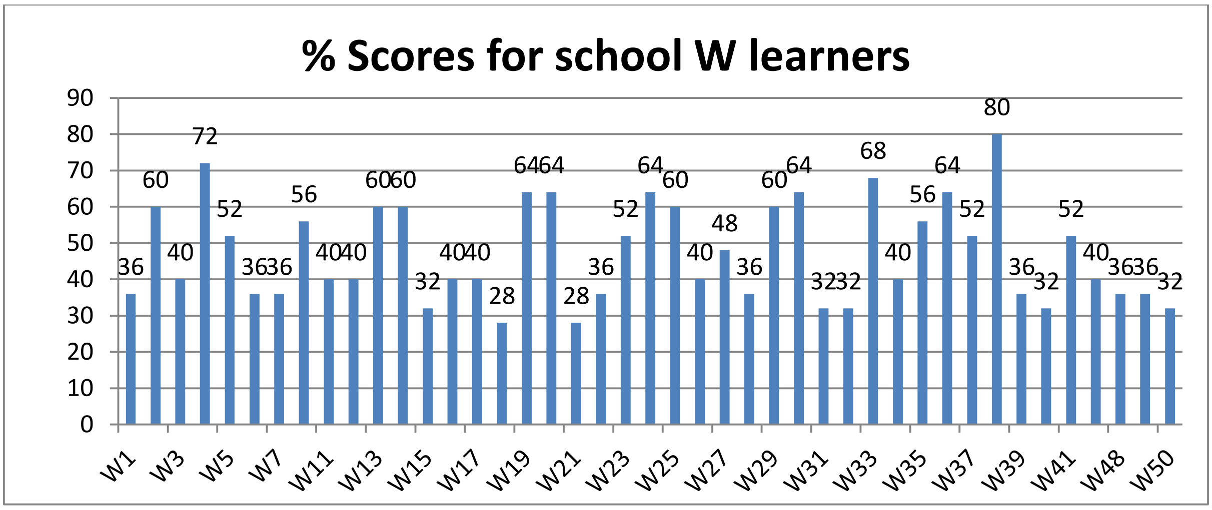


Fig.4.1: Questionnaire performance scores for learners in School W

Fig. 4.2 below indicates the words that were considered difficult for school W, and thus merited further investigation in terms of their contribution to the challenge experienced by learners in understanding their meanings in a science context.

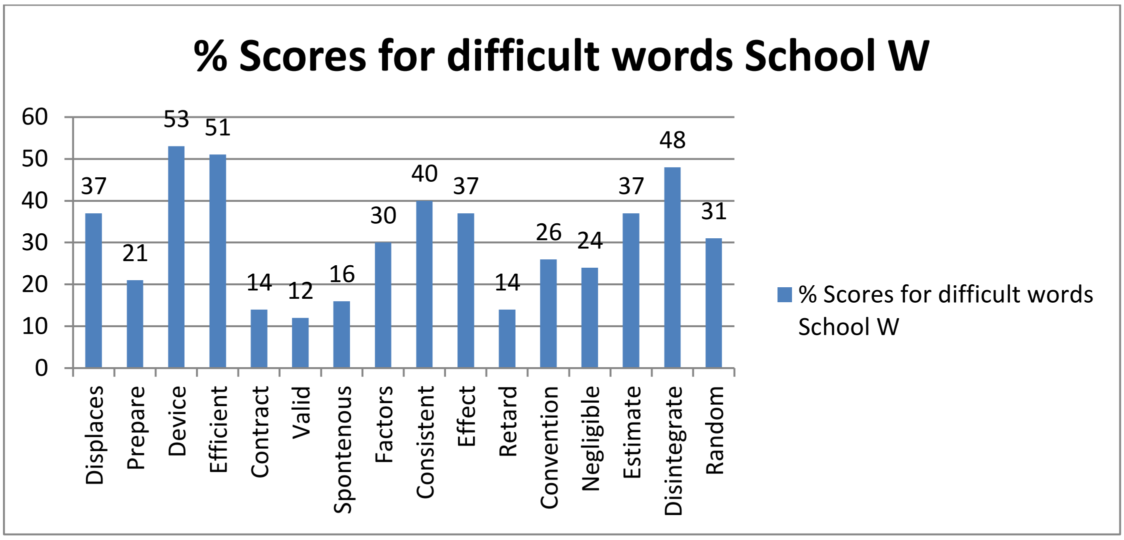


Fig. 4.2: Percentages versus words scores in School W

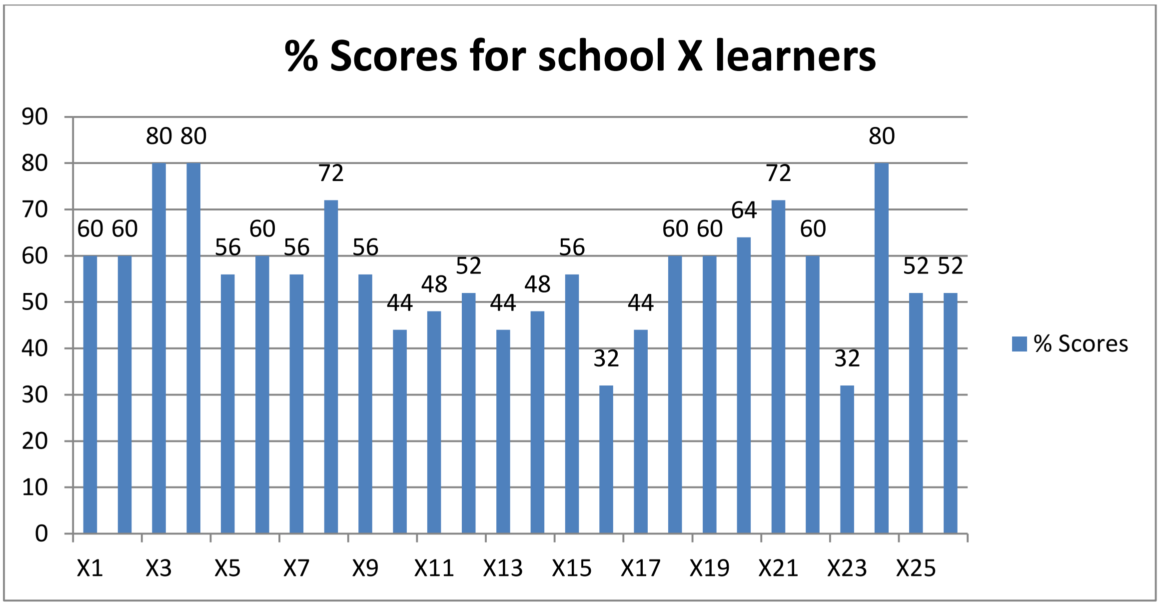
In school W, 16 words were considered difficult, as Fig. 4.2 illustrates. The words that met the criteria for difficulty in the study were identified as the following: Displaces (37%), Prepare (21%), Device (53%), Efficient (51%) Contract (14%), Valid (12%), Spontaneous (16%), Factors (30%), Retard (14%), Effect (37%), Consistent (40%), Convention (26%), Negligible (24%), Estimate (37%), Disintegrate (48%) and Random (31%), as shown in the graph 4.2. The most difficult word in this school was the word *"valid",* with a score of 12% correct responses (see graph 4.2), suggesting that most learners in the school did not understand the meaning of the word in science. Therefore, as Figures 4.1 and 4.2 illustrate, learners in this school did not, on average, demonstrate an understanding of the meanings of the words when used in a science context.

4.3.2 Questionnaire results: School X (N=26)

The overall performance of learners from school X is shown in Appendix G2, with a mean score of 56.9%. Fig. 4.3 illustrates the performance in school X. The highest score of 80% (n=3), indicated that none of the learners knew all the meanings of everyday words when used in a science context.

As Fig. 4.3 further shows, the lowest score of 32% (n=2), indicated that although all learners were familiar with some everyday words, their knowledge of using them in a science context varied and was limited. According to the criterion of 60%, only 46% (12/26) of learners understood the meaning of words in a science context.

Therefore, the overall scores suggest that the majority of learners in School X experienced a challenge in understanding the meanings of everyday words when used in a science context, as illustrated in Figures 4.3 and 4.4.



Graph 4.3: Questionnaire performance scores for learners in School X

Fig. 4.4 below shows the words considered to be difficult for school X, and which thus merited further investigation in terms of their contribution towards the challenge experienced by learners in understanding their meanings in a science context.

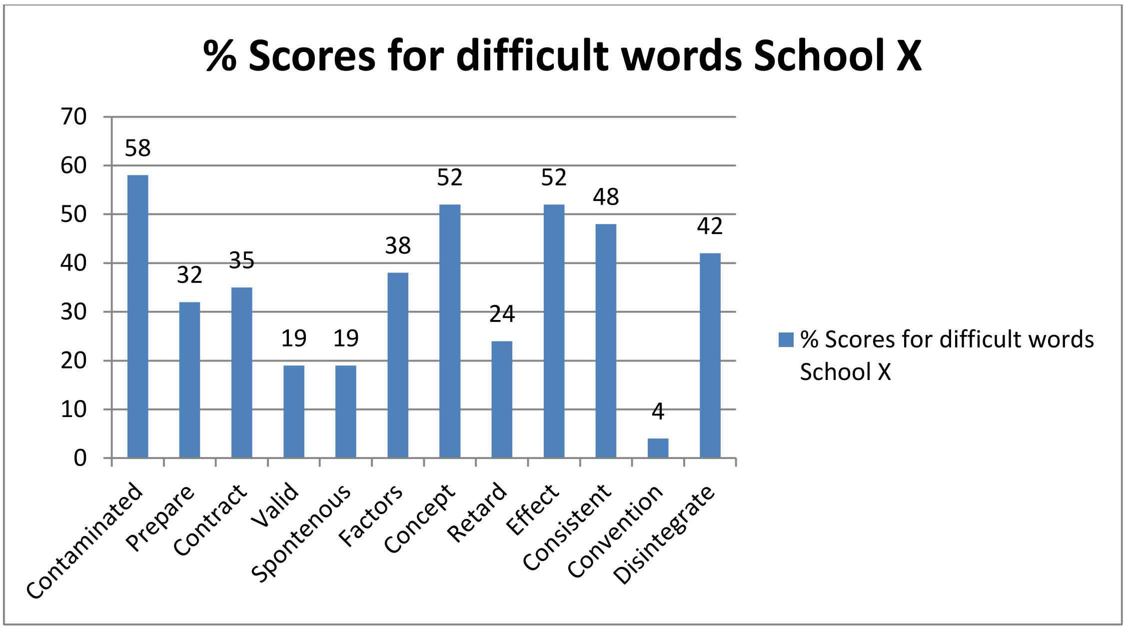


Fig. 4.4: Percentages versus words scores in School X

In school X, 12 words considered difficult, as illustrated in Fig. 4.4. The words that met the criteria established by the researcher for difficulty, and these words were identified as the following: Contaminated (58%), Prepare (32%), Contract (35%), Valid (19%), Spontaneous (19%), Factors (38%), Concept (52%), Retard (24%), Effect (52%), Consistent (48%}, Convention (4%) and Disintegrate (42%), as indicated in Fig. 4.4. The most difficult word in this school was the word "*convention*", with a score of 4% correct responses (see graph 4.4), suggesting that almost all learners in the school did not understand the meaning of the word in science.

Therefore as Figures 4.3 and 4.4 show, learners in this school did not, on average, demonstrate understanding of the meanings of the words when used or applied in a science context.

4.3.3 Questionnaire results: School Y (N=34)

The overall performance of learners from school Y is shown in Appendix G3, with a mean score of 55.2%. Fig. 4.5 below illustrates the performance in school Y. The highest score of 92% (n=1) indicated that none of the learners knew all the meanings of everyday words when used in a science context.

As Fig. 4.5 further shows, the lowest score of 24% (n=1) indicated that all learners were familiar with some everyday words, though their knowledge of using them in a science context varied and was limited. Only 38% (13/34) of learners understood the meaning of words in a science context (see graph 4.5). Therefore, the overall scores suggest that the majority of learners in School Y experienced the challenge in understanding the meanings of everyday words when used in a science context, as illustrated in Figures 4.5 and 4.6).

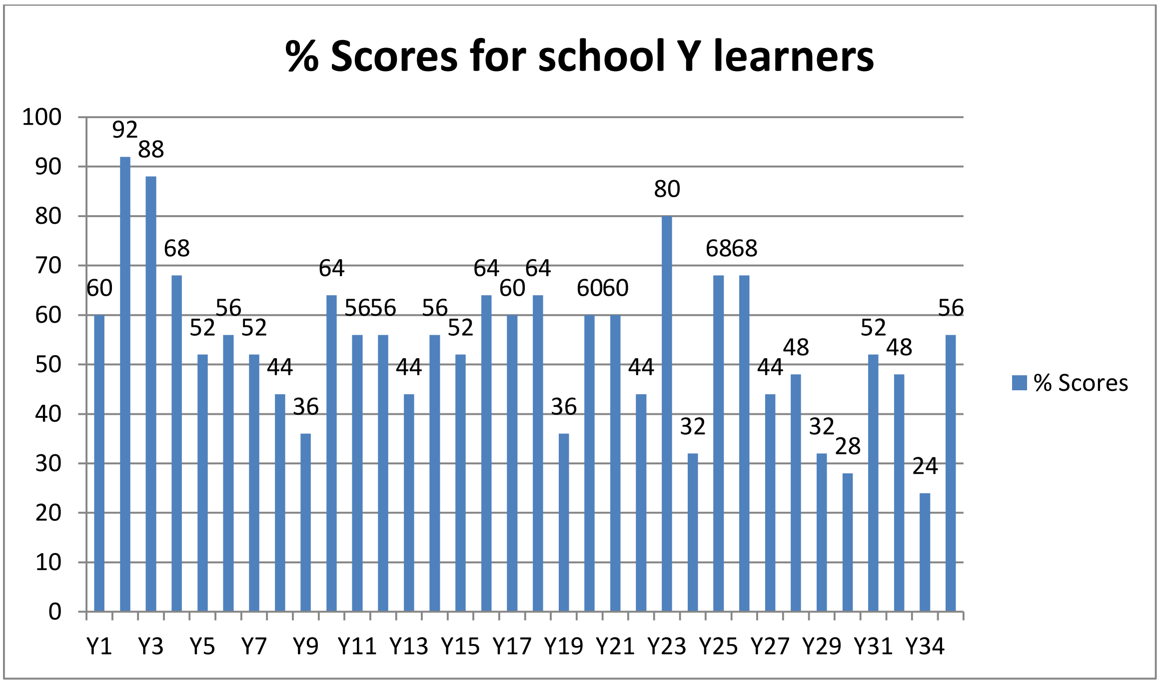


Fig. 4.5: Questionnaire performance scores for learners in School Y

Fig. Fig.4.6 below indicates the words that were considered difficult for school Y, and thus merited further investigation in terms of their contribution to the challenge experienced by learners in understanding their meanings in a science context.

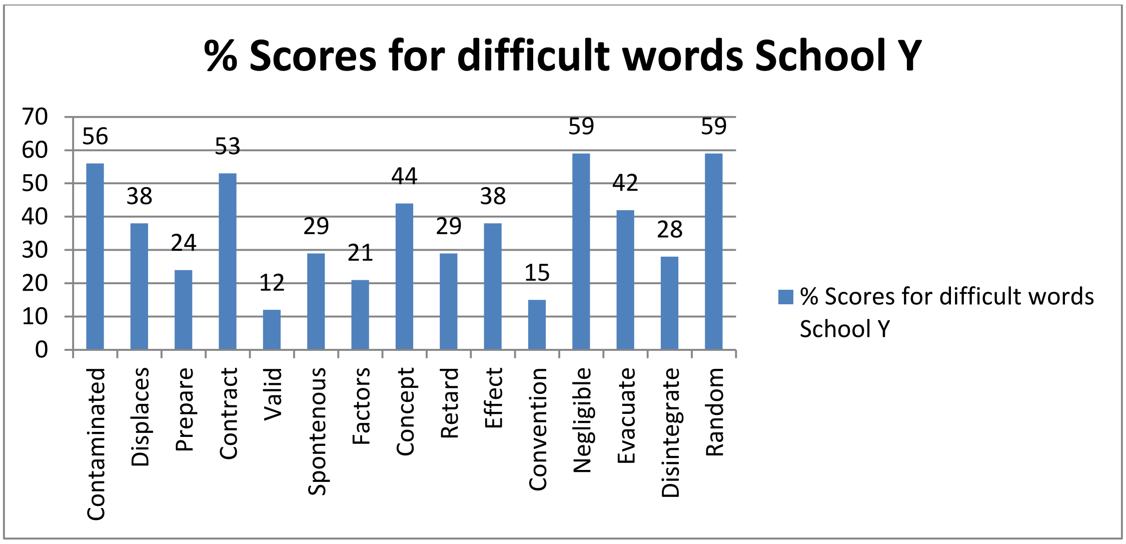


Fig. 4.6: Percentages versus word scores in School Y

In school Y, 15 words were considered difficult. The words met the criteria for difficulty established by the researcher, and the words were identified as the following: Contaminated (56%), Displaces (38%), Prepare (24%), Contract (53%), Valid (12%), Spontaneous (29%), Factors (21%), Concept (44%), Retard (29%), Effect (38%), Convention (15%), Negligible (59%), Evacuate (42%), Disintegrate (28%) and Random (59%), as shown in Fig. 4.6. The most difficult word in this school was the word *valid,* with a score of 12% correct responses, suggesting that most learners in the school did not understand the meaning of the word in science context. Therefore, as Figures 4.5 and 4.6 show, learners in this school did not, on average, demonstrate an understanding of the meanings of the words when used in a science context.

4.3.4 Questionnaire results: School Z (N=35)

The overall performance of learners from school Z is shown in Appendix G4, with a mean score of 57.2%. Fig. 4.7 below illustrates the performance in school Z. As Fig. 4.7 shows, the highest score of 88% (n=1) indicated that none of the learners knew all the contextual meanings of everyday words when used in science learning. The lowest score of 32% (n=1) indicated that all learners were familiar with some everyday words, though their knowledge of using them in a science context was varied and limited. Only 43% (15/35) of learners understood the meaning of words in a science context (see Fig. 4.7).

Therefore, the overall scores suggest that the majority of learners in School Z experienced a challenge in understanding the meanings of everyday words when used in a science context, as illustrated in Figures 4.7 and 4.8.

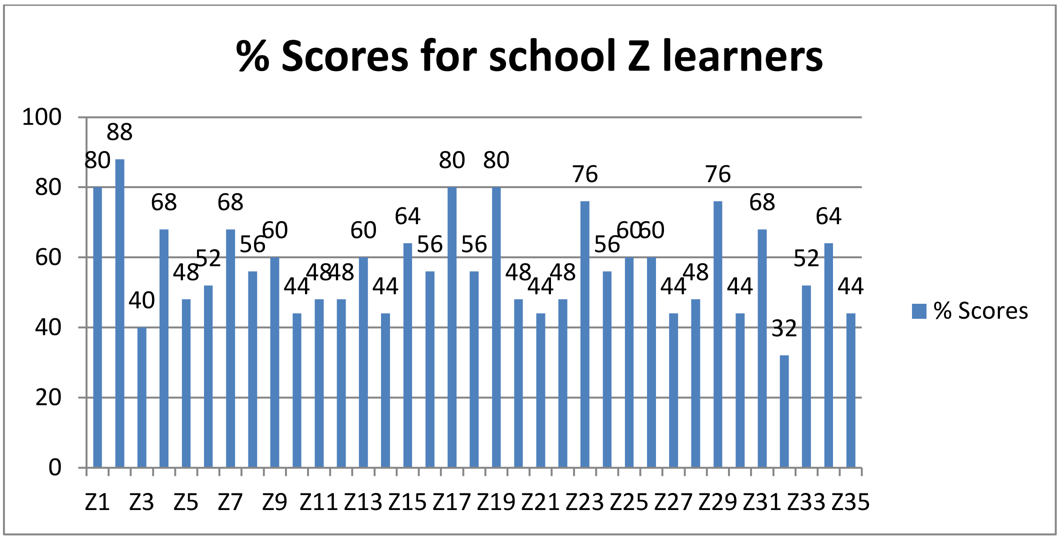
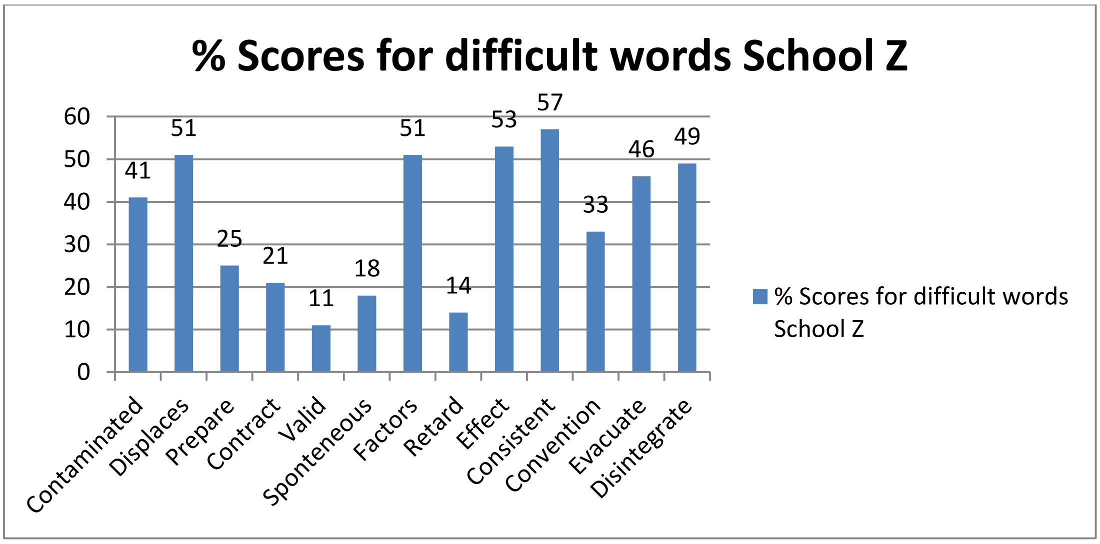


Fig. 4.7: Questionnaire performance scores for learners in School Z

Fig. 4.8 below shows the words considered difficult for school Z, and which thus merited further investigation for their contribution towards the challenge experienced by learners in understanding their meanings in a science context.



Fig, 4.8: Percentages versus word scores in School Z

In school Z, 13 words considered difficult, as illustrated in Fig. 4.8. The words met the criteria established by the researcher for difficulty in understanding, and included the following: Contaminated (41%), Displaces (51%), Prepare (25%), Contract (21%), Valid (11%), Spontaneous (18%), Factors (51%), Retard (14%), Effect (53%), Consistent (57%), Convention (33%), Evacuate (46%) and Disintegrate (49%), as indicated in Fig. 4.8. The most difficult word in this school was the word "*valid"*, with a score of 11% correct responses (see Fig. 4.8), suggesting that most learners in the school did not understand the meaning of the word in a science context. Therefore, as Figures 4.7 and 4.8 show, learners in this school did not, on average, demonstrate an understanding of the meanings of the words when used in a science context.

Table 4.1 below presents a summary of scores that compares word understanding in all the schools, and provides the average of each word in all the schools. Furthermore, the asterisk symbols attached to some words indicates that the words were eligible or qualified to be interrogated during the interview.

Table 4.1: Summary of Word Performance of four participating schools

Words	Percentage correct				
	Average	**School W**	**School X**	**School Y**	**School Z**
1. Contaminated	57	72	58	56	41
2. Displaces*	47	37	62	38	51
3. Prepare*	26	21	32	24	25
4. Dehydrate	96	100	100	91	94
5. Generate	74	74	73	68	82
6. Device	70	53	77	79	71
7. Crude	85	91	73	91	83
8. Efficient	63	51	62	68	71
9. Constant	91	79	100	88	97
10. Contract*	31	14	35	53	21
11. Valid*	14	12	19	12	11
12. Spontaneous*	21	16	19	29	18
13. Factors*	35	30	38	21	51
14. Concept	56	60	52	44	66
15. Linear	94	95	100	91	89
16. Retard*	20	14	24	29	14
17. Effect	45	37	52	38	53
18. Consistent*	51	40	48	60	57
19. Convention*	20	26	4	15	33
20. Negligible	55	24	68	59	69
21. Evacuate	53	60	62	42	46
22. Estimate	72	37	81	85	86
23. Conserve	85	71	96	81	91
24. Disintegrate*	42	48	42	28	49
25. Random	54	31	62	59	63
School Average %	**54.1**	**47.2**	**56.9**	**55.2**	**57.2**

* words qualifying for inclusion in the interviews

The ten words appearing on table 4.1, namely Displaces, Prepare, Contract, Valid, Spontenous, Factors, Retard, Consistent, Convention and Disintegrate, emerged as common difficult words in all four schools. The word ‘Effect’, which performed 45% on average, was overlooked, and the word ‘Consistent’ with an average of 51%, was chosen instead for the interviews. The word ‘valid’, which performed the worst, was considered as the most difficult word, with a score of 14% in all four participating schools (see table 4.1). This sugests that only 13% (18/138) of the learners who took part in the study understood the word ‘valid’ when used in a science context (see appendices G1-G4).

Fig. 4.9 bellow illustrates the words which were commonly found to be difficult, when compared to the percentage of performance scores for each word per school.

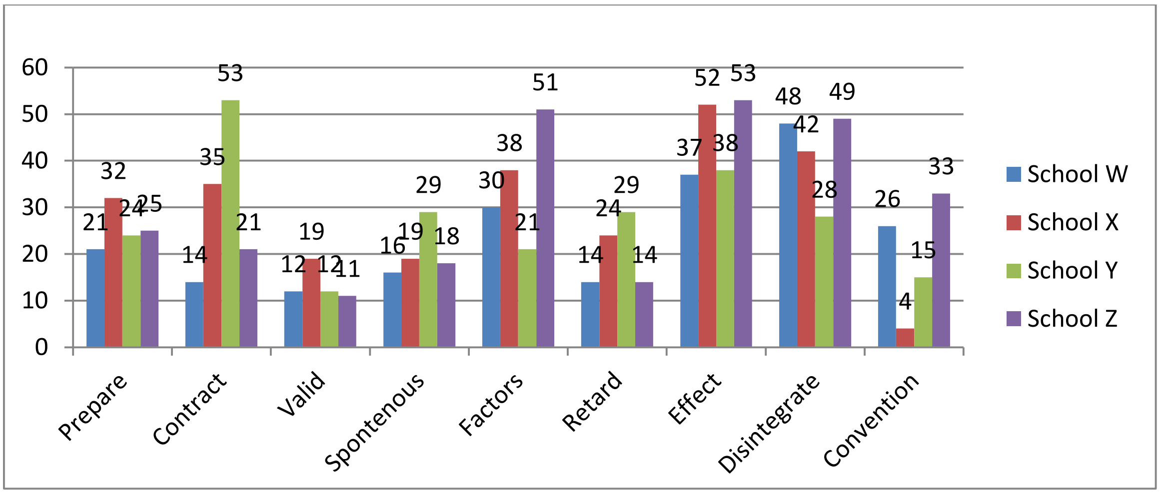


Fig. 4.9: Common scores for difficult words in schools W, X, Y and Z

The words Displaces, Prepare, Contract, Valid, Spontenous, Factors, Retard, Consistent, Disintegrate and Convention had average scores of 47%, 25.5%, 30.8%, 13.5%, 20.5%, 35%, 20%, 51.4%, 41.7% and 19.5% respectively in all four schools (see Fig. 4.9). It can be concluded that the learners in these schools experienced common problems in understanding their meanings in a science context. All four schools obtained average scores in these words that were far below the set criterion of 60% for difficulty of understanding words.

Thus the study demontrated that Grade 11 Physical Sciences learners in the Gauteng East District encountered difficulties with everyday words when used in a science context, with specific reference to the questionaire findings.

Another commonality was discovered in terms of word understanding. As shown in Table 4.2 below, learners in all the schools tended to choose common incorrect responses (symbol in bracket) as answers to the questions.

Table 4.2: Difficult words and corresponding popular choices of responses

Words	**Popular choice of responses by all learners**
Prepare	what substances are needed to make it (D)
Contract	change colour (A)
Valid	brief (A)
Spontaneous	was very quick (A)
Factors	the method (A)
Retard	speed up the reaction (A)
Effect	the reason for adding the acid (A)
Convention	is a result of chemical formula (A)
Disintegrate	change colour (B)

In comparing the samples of the four schools in this study, it was found that a significant number of learners had a common popular choice of incorrect responses. For example, the word *'prepare'* was considered difficult in all four schools: in school W, 26 the of 43 learners chose the common incorrect response D (see appendices G1). In school X, 12 of the 26 learners also chose D as an answer to the question (see Appendix G2). In school Y, 18 of the 34 learners also chose D as an answer (see appendices G3) and in school Z, out of the 35 learners, 23 chose D as an answer to the question (see Appendix G4). The meaning of the word '*prepare'* was mistakenly understood as "what substances are needed to make it", instead of the intended meaning, namely "how it is made". In all four schools, 79 of the 138 (57%) learners made the incorrect choice of D as an answer. One possible explanation could be that the majority of learners thought that the everyday word does not differ in meaning from its use in the scientific context.

4.4 INTERVIEWS RESULTS

4.4.1 Learner interviews

The researcher identified ten words in all four schools as suitable for probing participants, because most of them appeared to have low percentages in terms of correct responses. In the following order, they were considered extremely difficult for participants to understand: Prepare (25%) in school Z, Contract (14%) in school W, Valid (12%) in school X, Spontaneous (16%) in school W, Factors (21%) in school Y, Retard (14%) in school Z, Convention (4%) in school X, Consistent (40%) in school W, Displaces (38%) in school Y, and Disintegrate (28%) in school Y. These words remain key to the understanding of sentences that explain science concepts.

The recordings of the participants' views on the words were captured on the interview schedule as participants explained their responses. Furthermore, the verbatim audiotape recordings of learner participants which was transcribed into a categorised format which facilitated analysis, revealed a lack of understanding of the selected words when they are used in a science context. Participants expressed varying opinions on each word that was discussed during the interview, but also presented an almost unique problem with each word. The researcher identified questions from the interview schedule and used them to probe the participants. The following is a record of the interview responses to each word.

Keys: 'R' represent the researcher or interviewer; 'L with a number' represents a learner interviewee; 'All' represents all learners interviewed and 'S' represents some of the learners interviewed

1. Prepare

The question item in the questionnaire was presented as follows:

3. If you are asked to describe how you prepare oxygen, it means you are to say

   A. How it is made.

B. What it is used for.
C. How it behaves.
D. What substances are needed to make it.

The highest combined percentage of the participants was **26%** (Table 4.1). The correct response was (A), “how it is made“

Comment: Clearly, the participant confused the literal meaning of the word prepare with how the word is used in science i.e. how it is made as one learner expressed ‘Sir in our daily lifestyles when we prepare for school we use the word prepare your uniform and stuff like that’. The word was used to provide the literal meaning.

2. Contract

The question item in the questionnaire was presented as follows:

10. The experiment was designed to prove that the brass rod would contract as the temperature fell. This means the rod would
    A. Change colour
    B. Slacken
    C. Become longer
    D. Become smaller

The highest combined percentage of the participants was **31%** (Table 4.1).The correct response was (D),“become smaller“.

Comment: The participants generally understood the literal meaning of the word, but applied it incorrectly in explaining the wave concept, which is used in science context as expressed by one learner: ‘when they tell us that maybe the magnitude of the wave or something has contracted (then murmuring)’.

3. Valid

The question item in the questionnaire was presented as:

11. The teacher felt that the learners’ interpretation of experimental results was valid. This means the teacher felt it was
    A. Worthless
    B. Not correct
    C. Brief
    D. Sound

The highest combined percentage of the participants was **14%** (Table 4.1).The correct response was (D), “sound“

Comment: The participants could not apply the word in a science context, but understood it as something which is acceptable as a learner responded ‘I think is something that is correct and something that has accurate meaning or an accurate answer’.

4. Spontaneous

The question item in the questionnaire was presented as follows:

12. The two chemicals seemed to combine in a spontaneous reaction. This means the reaction
    A. Was very quick
    B. Was explosive
    C. Once started increased vigorously
    D. Happened by itself

The highest combined percentage of the participants was **21%** (Table 4.1). The correct response was (D),“happened by itself“.

Comment: Most participants understood the meaning of the word in the social context of beauty, but could not link it with any science activity as shown ‘The last time I heard of spontaneous it was when I was watched a series on television this guy was giving compliments on this girl and said you look spontaneous but what then arrived into my mind I thought he was just meaning you are extremely gorgeous or very beautiful’.

5. Factors

The question item in the questionnaire was presented as follows:

13. The outcome of the chemical reaction depended on many factors. This means that it depended on
    A. The method
    B. Influences
    C. Systems
    D. Accomplishments

The highest combined percentage of the participants was **35%** (Table 4.1). The correct response was (B),“influences“.

Comment: The explanations given by the participants were mostly link to methods used in other subjects, such as agricultural sciences. The participants clearly lacked an understanding of the use of the word in different contexts as expressed by a learner ‘Ha ah. I think factors are things that are used in a certain individual maybe in an experiment the method that they use or the experiment that they use I think those can be the factors or wanting to know something that could affect something’).

6. Retard

The question item in the questionnaire was presented as follows:

16. The learner was trying to find a chemical that would <u>retard</u> the reaction. This means the chemical would
    A. Speed up the reaction
    B. Slow down the reaction
    C. Make the reaction go the other way
    D. Give maximum yield from the reaction

The highest combined percentage of the participants was **20%** (Table 4.1). The correct response was (B), “slows down the reaction“.

Comment: Most of the participants who were interviewed did not know the meaning of the word at all. However, one participant understood the word as meaning to drag something, which the researcher felt was incorrect ‘I think is to pull something’.

7. Convention

The question item in the questionnaire was presented as follows:

19. By <u>convention</u>, when writing a chemical formula, the symbol of a metal is usually written first. This means that this way of writing
    A. Is a result of a chemical formula

B. Has been accepted as an agreed practice
C. Was developed as metals were discovered first
D. Has been arrived at but is still the subject of controversy

The highest combined percentage of the participants was **20%** (Table 4.1). The correct response was (B), “has been accepted as an agreed practice“.

Comment: Most participants interviewed confused the word, which sounded like the word they knew, and provided meaning of the other word. The word convention was clearly confused with conversion as expressed by the comment of the learner ‘But convention is like you convert something you change a drink from orange to blue’.

8. Disintegrate

The question item in the questionnaire was presented as follows:

24. The tube may <u>disintegrate</u> when the reacting gases are released into it. This means the tube may
    A. Be seen to glow
    B. Change colour
    C. Break up into small pieces
    D. Collapse in on itself

The highest combined percentage of the participants was **42%** (Table 4.1) .The correct response was (C),“break up into small pieces“.

Comment: The participants were familiar with the word, but only understood the meaning of the word in the context of breaking something rather than separating into parts as understood in the physics study. The learner said ‘I think when breaks down something into smaller pieces.

9. Consistent

The question item in the questionnaire was presented as follows:

18. The results of three experiments were consistent. This means the results were
    A. Variable
    B. Adequate
    C. The same
    D. Adjusted

The highest combined percentage of the participants was **51%** (Table 4.1).The correct response was (C), “the same“.

Comment: Although this word was only common to three schools, it did fit in the category of difficult words, as its value of 48.3% was below 60% criteria. The participants clearly confused the words, which sounded alike, and provided the meaning of the word constant instead ‘I think consistent is something which is constant’.

10. Displaces

The question item in the questionnaire was presented as follows:

2. When the stone is lowered into a beaker of water, it displaces some of the water. This means it
    A. Reacts with some of the water.
    B. Simply falls through the water to the bottom of the beaker.
    C. Gets bigger.
    D. Pushes away some of the water.

The highest combined percentage of the participants was **47%** (Table 4.1).The correct response was (D),“pushes away some of the water“.

Comment: Clearly the participants confused the word with misplace and displacement, which is a physics concept, and yet lacked the understanding of the meaning of the word in a science context ‘Another word for forgetting something you have displaced it or you have forgot it or you have placed it carelessly yes’.

The word ‘***effect***’, with an overall score of 45% (Table 4.1) and qualified to be interviewed according to the set criteria, was not interviewed for reasons beyond control. It will be recommended for interview in future studies. Instead the word **‘*consistent’*** with an average score of 51% was interviewed.

4.4.2 Teacher interviews

The reason for conducting teacher interview was to establish from teachers awareness of difficulties learners have of using everyday words in a science classroom. Information obtained from this exercise was useful to identify factors causing the problem as they relate to the objectives of the study.

Furthermore, teachers participating in the study were asked to share their views of the learners’ difficulties in understanding the use of everyday words in a science context.

4.4.3 Interview with a teacher – School W

Mr. P, in school W (see table 3.1) was also interview on one of the worst performing word **Spontaneous (21%)** (Table 4.1) in the questionnaire.

R: Good morning sir.

Mr. P: Morning sir.

R: I am conducting this interview to make a follow-up to the responses learners gave in the questionnaire and the subsequent interview I conducted with them on the understanding of the meaning of certain words when they are used in a science context. Those learners expressed various views on their understanding of the meaning of words in a science class. I want us to focus on the word **‘spontaneous’**. Do you remember using this word in your science class?

Mr. P: Yes I remember using it I was teaching a topic on reactions. The kind of spontaneous reactions and the like.

R: Do you think learners had the same understanding as yours?

Mr. P: Not exactly, some they did and some did not because they saw the meaning in a different way than mine.

R: Now tell me, if the learners did not understand the meaning of the words where do you think learners might have got the misconception.

Mr. P: I think maybe from home because usually they use the words at home referring to a certain meaning but now when coming to a science class only to find out that the word has a different meaning. So that's where they have the confusion.

R: Tell me do you think other subjects could have influenced the way they have responded?

Mr. P: Yes in English, maybe if they can have a good background also their home language because they must translate from their home language for better understanding.

R: Actually I was about to ask you about language background if it has to do with misunderstanding of meanings of words.

Mr. P: Ja maybe the language background influences because in science some words they are better understood in a scientific language then we have life science language, home language and so forth. Sometimes you find out that the learners knows a word in his or her home language referring to certain things but when coming to science that's where you going to have a problem.

R: Do you think besides language background, there is any other influence maybe?

Mr. P: Let's say the environment in particular the media is also a factor for them not to understand because they talk generally and these kids get use to use the words any how like I said in science we have our own language and the media have has its own language.

R: Thank you very much sir.

4.4.4 Interview with a teacher – School X

Ms. K, a physical sciences teacher (see table 3.1) was interviewed on the word **valid (14%)** (Table 4.1).

The reason for choosing the word was that the word was the worst performing word as most learners could not understand the meaning of the word when used in a science context. The teacher responded as follows in the interview:

R: Good morning mam

Ms. K: Morning sir.

R: In the questionnaire learners were asked to respond to a set of question and also the follow-up interview was conducted with them to establish their understanding of the meanings of words in a science context. For example one of the words asked was the word **'valid'**. Do you remember using the word valid in your lesson?

Ms. K: Mhhhh….I do not use the word often but then I can say maybe five percent of the time.

R: Do you remember which topic you were teaching?

Ms. K: Eh..no its usually a word which will appear in all topics.

R: I mean specifically in a particular topic.

Ms. K: No there was no specific topic but for any topic in science is the word you can use.

R: Do you think learners may have the same understanding as yours?

Ms. K: No I think I have to explain the word and refer them to dictionary to understand the word first but I don't think they understand the word as I do.

R: Fine. If you think learners do not understand the meaning of the word, where do you think the learners get the misconception of the word from?

Ms. K: Number one they could fail to fail to understand the meaning of the word itself, number two they would have a misconception about the word, like confusing valid and validating.

R: Okay mam, do you think their language background could influence their understanding of the meanings of words?

Ms. K: Yes, very much so. Their language influences their understanding of science words and concepts. For example the word valid itself, most of them will not know what the word means. Their understanding of the English language has a bearing on their understanding of science. Maybe if they use their home language they will better understand but with English as a second language, there is that language barrier and the subject itself.

R: Mam in your opinion do you think there can be any other reason why learners could give these responses?

Ms. K: Mainly is obviously the language barrier and secondary is that learners tend not to expose themselves in different types of resources and information regarding their subject.

R: Lastly, what do you think the influence of media have on word understanding in a science class?

Ms. K: Yes that could also be an influence, you find that they use informal slang and that changes the actual meaning of words. So you find that most of them they use slang in a formal situation. Therefore those words will not have the same meaning. For instance they shorten words when using social media and SMS messages in mobile phones.

R: Thank you madam

Ms. K: Thank you sir.

4.4.5 Interview with a teacher – School Y

Ms. P, a physical sciences teacher (see table 3.1) was interviewed on the word **convention (20%)** (Table 4.1). The reason for choosing the word is that the word was one of the worst performing words as most learners could not understand the meaning of the word when used in a science context. The teacher responded as follows in the interview:

R: Good afternoon mam

Ms. P: Good afternoon sir.

R: I would like to thank you for honouring this interview. This is actually a follow up interview about the questionnaire filled by learners and a subsequent interview about the use of everyday words in a science classroom. Learners gave a particular meaning for the word **'convention'**. Mam do your remember ever using this word in your lesson?

Ms. P: Thank you sir. I also appreciate the opportunity to take part in the interview. And then yes I did involve the word during my teaching more especially when we deal with circuit diagrams whereby the current must flow using the conventional current. I explained to learners what this conventional current is. Actually is an instruction to say that learners must know that electrons must start to move its standard information that they must know that electrons must start to move from positive terminal to negative terminal of the cell.

R: I can see that you are referring to electricity neh?

Ms. P: Yes

R: But do you also use this word in other topics. In which particular lesson maybe?

Ms. P: Yes. More especially in grade 11 when we deal with VSEPR (valence shell electron pair repulsion) where learners must give names of structures because they have to use a specific formula when they write the name of that structure whereby its convention like for instance if it's a tetra you know that therefore like carbon tetrachloride the leaners must know the name of that structure whereby carbon is surrounded by four chlorine so the formula for that structure its by convention it's an agreement that if there are four any other atoms around that atom because each carbon can have a maximum of four elements. Like for instance as I said they can use chlorine they can use hydrogen they can use fluorine like in the case of chlorine they have to say carbon tetra chloride because tetra means four. Therefore that's convention whereby there is a standard there is an agreement to say if there is a carbon around the carbon there is a certain atoms the maximum that they can contain is four atoms then it's called tetra.

R: Ok thank you mam. Do you think that the learners have the same understanding as yours?

Ms. P: No I think its difficult for learners to actually interpret this term more especially scientifically. They always think of converting when you talk of convention because in science we talk of conversion. When you convert you move one unit to the other. So in terms of convention it's a standard its an agreement of some sort to say this is the way of saying or naming this. So it was a little bit of challenge because I need to explain the difference between the two words.

R: Thank you mam. Now if the learners do not understand the meaning of the word or give wrong answers where do you think the misconception come from?

Ms. P: The misconception comes from the language itself. They have got a language barrier I believe so because you know the term starts from English and take it to scientific class you know scientific language because if they have understood clearly the word from English then the science teacher try to link and show the learners the difference between the two I think it will resolve the matter I can say the problem lies on the language class.

R: Do you think answers to the meaning of words generally have been influenced by other non-language subjects.

Ms. P: Yes absolutely as I said that you know English is the medium of instruction so leaners before they go science class they have to understand the language first English is the language then take these learners from English class to science because there we use a scientific language same term from English but now the interpretation differs so hence these other subjects they play a major role so we need to collaborate with them we need to interact and share the emphasis of terminologies so that learners can understand these terminologies so that it can be easy in Physical sciences.

R: Do you think the answers to science words, in general given by learners are in a science classroom is influenced by their language background?

Ms. P: Yes I think the language background is a serious challenge because if you don’t know the meaning of the word you cannot utilise that word accordingly but if you have the understanding of the word then it will be much easier you know so if I know the meaning of the word convention from the English class come to science now it’s a challenge. Another challenge is code switching because when I am teaching science I must strictly use English so that the learners can get used to it and then when I go to home language I must strictly use home language because these learners battle with their home language do you know that? Reason being code switching when they talk. Even educators code switch when they teach home language, English will come in somewhere. And then same applies when you teach English, a Zulu word will come in so if we can learn as educators to say let’s focus on a language when we teach lets not code switch. When I am teaching a content let me use a relevant language like I am teaching science let me use the scientific language of which is related to English. Yes in class the teacher must explain those English terminologies and teach learners how to utilise them showing the understanding of words bring more examples so that the learners can understand and able to interpret application of those words.

R: Thank you very much mam.

Ms. P: Is that all?

R: Yes mam

Ms. P: Okay bhuti (giggling)

4.4.6 Interview with a teacher – School Z

Ms. M, in school Z (see table 3.1) was also interview on one of the worst performing word **Prepare 26%** (Table 4.1) in the questionnaire.

R: Good day mam.

Ms. M: Good day sir.

R: Thanks for attending the interview. Mam I want us to talk about a particular word in the questionnaire which learners responded to and to the views learners expressed about the word in the interview. The word is **'prepare'**. Do you remember using the word in your lesson?

Ms. M: Yes as part of Acid and Base reactions as in titrations were a standard solution has to be prepared. So we mix a certain amount of mass of a substance and then with water so I guess that's where we use the word prepare. So we are preparing a solution.

R: Do you think learners have the same understanding as yours?

Ms. M: I don't know but most of the time they don't because the everyday use of words is different from the scientific use so they can be mistaken when they use the word.

R: So if the learner did not understand the meaning of the word in a science context where do you think the learner might have got the misconception?

Mr. M: Maybe the misconception will come with English as these words might differ in meaning with science. Like when you prepare in English maybe you preparing to come to school, taking a bath and all that. So some of them might think of it in that way.

R: Okay, how do you think that this could be influenced by non-science subjects?

Ms. M: Yes it can most of it. Subjects like English and Life orientation.

R: So they use the words differently?

Ms. M: Yes from the way we use them.

R: Do you think the misunderstanding of the meaning of the word is influenced by the language background of learners?

Ms. M: It can be because all our learners are doing English as a second language and most don't speak at home and that they come across English here at school so it influences it in a very big way because English is not our home language. Most of them struggle.

R: Okay. So do you think there is any other reason the learner has a problem with the use of the word in science?

Ms. M: I think a lot of things play part in teaching and learning science. It's not about them coming just to school their basic foundation from primary schools is important so probably some have knowledge gaps and they don't know what's happening and here when we introduce new concepts it's just a mess.

R: Thank you very much mam

Ms. M: Thank you

The discussion above illustrates anecdotes that emanated from the interviews conducted with teachers and learners, revealed that comments made by learners showed their limited understanding of the meanings of everyday words when used in a science context. In an interview conducted with Mr. P from school W, he stated that "sometimes you find out that the learners knows a word in his or her home language referring to certain things but when coming to science that's where you going to have a problem".

In further discussions with teachers, it transpired that they did not realise the impact the challenge of using everyday words in science context might have on teaching and learning science.

4.5 SUMMARY

The findings of the study, through data analysis presented in this chapter, suggest that Grade 11 learners in township, secondary schools still experience challenges with regard to using everyday words in a science context. The results of the present study on word understanding show clear similarities to the review findings of Farrell and Ventura (1998:250). Further findings suggest that teachers did not pay attention to, or were not aware of, the existence of this challenge. Responses given by participants on other words in the interview have revealed the following; an understanding that is opposite to the actual meaning (contract), no understanding of the meaning at all (spontaneous, retard, random), confusing words which sound alike (convention), and only understand the English meaning of the word, but not in a science context (valid, prepare, factors). In the next chapter, the researcher will present the conclusion, limitations, recommendations, and reflections of the study.

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

5.1 INTRODUCTION

In this study, the questions were posed: What problems do learners encounter in using English words in a science context? What are the factors that are affecting learners' understanding of English words when they use them in a science context? Are teachers aware of the prevalence of this problem? Therefore, this chapter concludes the study by highlighting the synergy between the findings with the objectives and research questions of the study. The questionnaire results have indicated that Grade 11 Physical Sciences learners from the four township secondary schools encounter difficulties in understanding the meanings of everyday words when used in a science context. The follow-up interviews conducted with participating learners helped in answering research questions posed in the study, as learners themselves were able to elaborate on their understanding of everyday words in a science context. The interviews conducted with teachers indicated that they were aware of the difficulties experienced by learners in the understanding of everyday words when used in a science context, but were not sure how to deal with the problem. In this chapter, the researcher also discusses the limitations of the study and makes recommendations on how to improve the situation.

5.2 SUMMARY OF FINDINGS

The results of the study indicate that there is general difficulty understanding and using everyday English words in a science context. The sources of difficulties included word familiarity, confusion with words which sound alike, misreading and precision in the use of words, and possibly lack of proficiency in the language of teaching and learning. However, in this study, language proficiency was not assessed. Furthermore, the study has revealed that there are language problems in the learning of science with regard to use of everyday English words in a science context, which emanate from language background of learners.

In addition, during the interviews conducted with teachers, the researcher deduced from their responses that much as they were aware of learners' difficulties with the language of instruction, they did not recognise the impact the language has in learning of science.

5.2.1 Questionnaire

Judging from the overall results obtained from questionnaires (see Appendices G1-G4), many learner participants in all four schools experienced difficulties in understanding the meanings of everyday English words, as used in a science context. The average results in terms of correct responses of School W (47.2%), School X (56.9%), School Y (55.2%) and School Z (57.2%) suggest that the problem exists in all four schools (Table 4.1).

Table 4.3 below presents the descriptive statistics established in analysing the questionnaire data. The parameters supplied on the table 4.3 provide a statistical comparison of the questionnaire results.

Table 5.1: Comparative descriptive statistics of correct questionnaires scores for schools W, X, Y and Z.

	School W	School X	School Y	School Z
Sample size	**N = 43**	**N = 26**	**N = 34**	**N = 35**
Mean score (of correct responses)	$\frac{2032}{43} = 47.2$	$\frac{1480}{26} = 56.9$	$\frac{1844}{34} = 55.2$	$\frac{2004}{35} = 57.2$
Standard Deviation (of % scores)	**σ = 13.56**	**σ = 12.6**	**σ = 15.3**	**σ = 13.3**

The low deviations from the mean between each school suggest that the prevalence of the problem is comparable, except for school W, which had a slightly lower percentage mean. The higher value for the standard deviation of all the schools (see table 4.3), highlights that more learner participants scored further from the mean score. In statistics and probability theory, a standard deviation shows how much variation or dispersion exists from the average (mean), or expected mean, with a high standard deviation indicating that the data points are spread out over a large range of values (Bell & Waters 2014:282). Such statistical values confirm the prevalence of word understating in a science context in all four schools.

5.2.1.1 Gender discrepancy in questionnaire performance

The sample used in the study consisted of 71 female learners and 64 male learners, as indicated in the Table 4.4 below. Furthermore, table 4.4 represent a comparison of gender performance based on descriptive statistics.

Table 5.2: Comparison of performance based on gender.

	Female (girls)	**Male (boys)**
Sample size	**N = 71**	**N = 64**
Mean score (of correct responses)	$\frac{3672}{71} = 51.7$	$\frac{3524}{64} = 55.0$
Standard Deviation (of % scores)	**σ = 14.8**	**σ = 14.0**

The percentage mean of achievement for female learners (51.7%) was slightly lower than that of male leaners (55.0%) in the questionnaire, but both were at level four, according to DBE performance ranking. The higher value for the standard deviation in both boys and girls (see table 4.4) highlights that both the genders scored further from the mean score. Therefore, their achievement could be comparable. However, Musa, Dauda and Umar (2016:173) argue that findings of scant gender difference in English language and overall academic performance in the present study, also contradicts the traditionally held belief and reports from western countries that females perform significantly better than males in all aspects of English language.

5.2.2 Interviews

5.2.2.1 Learners

The interviews provided a word-of-mouth perspective, as learner participants expressed their understanding and meanings of words used in a science context. The general outcomes of interviews with learner participants revealed, judging from the verbatim responses that they gave, a low level of understanding of meanings of everyday words when they used in a science context. For example, the word '*valid'* which scored an average of 13.5% in all four schools, proved to be the most difficult word to use in a science context, since it was understood in one context by most learners, and misunderstood when used in another context, such as the science context

5.2.2.2 Teachers

The teacher interviews revealed that teachers' language skills and their approach to the use of language in a classroom have also contributed to this problem. The teachers in the study attested to this view, though not openly, by alluding to the fact that they are not in a position to fully address the language problem of learners, because they themselves are second language users.

5.3 DISCUSSION

5.3.1 Introduction

The focus on discussions is on the results obtained from the instruments that were used, namely questionnaire and interviews. The researcher explained how these instruments were useful in providing the data necessary for this study. The overview of the findings demonstrates that there is a general difficulty with many words in a science classroom in the language of instruction, which is English. Once again, the general conclusion drawn was that a significant number of students had a lack of understanding of the meanings of most words (Farrell & Ventura, 1998:245). The types of difficulties encountered by the learners with this category of words include:

5.3.2 Lack of familiarity with words

Maznah and Zurida (2006:7) noted that a more acute problem lies in the use in science of normal, familiar language in a highly specific, often-changed and unfamiliar way. In this regard, it is important to learn the principles governing their formation and use, as well as a few basic strategies for dealing with unfamiliar words (Orr & Schutte 2003:5). Conversely, Rollnick (2000:107) referring to Prophet and Towse (1999), states that at secondary school level, similar findings in Botswana and Britain emphasised that the use of familiar words in science context presented great difficulty to second language learners. In terms of the word "spontaneous" (question no. 12), which scored low in the questionnaire (21%) and stood out as one of the difficult words for learners (see Table 4.1), most learners indicated that they heard of this word for the first time in the interview. The following excerpts from the interview on the word *spontaneous* attest to this view.

R: The next word I want us to discuss is "**spontaneous"**. Do you recall the word in the questionnaire?
All: Yes yes yes
R: Spontaneous means what?
All: (murmuring)
R: I am listening
All: (giggling)
L5: The truth is it's not the first time I heard of it but it's the first time I had to elaborate it that I had to.
L6: From my information I thought that spontaneous is something which is glittering ehh.. I have never heard of the definition.
L7: Most of the time I have heard it on media television and radio stations.
R: But do you remember in which topic do you use this word?
L4: The last time I heard of spontaneous it was when I was watched a series on television this guy was giving compliments on this girl and said you look spontaneous but what then arrived into my mind I thought he was just meaning you are extremely gorgeous or very beautiful.

The responses provided by learners indicated that the issue of the familiarity with words poses a problem in understanding Physical Sciences.

5.3.3 Confusion about words which sound alike (phonetically)

One of the findings in the study was that learners confused words which sounded alike. Words with similar sound often created confusion in the minds of learners, and affected their understanding of these words in a science context. Therefore, words which look alike or have similar sounds when pronouncing them can create confusion in the minds of the learners, resulting in the learners failing to understand the meanings of everyday words when used in the science context (Semeon 2014:67). In the questionnaire, the word "convention" (question no. 19) averaged 20% of correct responses in all four schools (see Table 4.1). Furthermore, in the Interview conducted with learners, the word "convention" was confused with the word "conversion". The following excerpts illustrate this point.

R: Ok thank you very much. There was the word **convention**. In the questionnaire - do you remember this word?

All: Yes sir

R: Are you familiar with this word?

L1: Mmmm… it means something which has been converted, like a machine. It could be people's ideas or creativeness in making that is one.

R: But do you use this word when learning physical sciences?

All: Yes

L2: But convention is like you convert something – for example, when you change a drink from orange to blue.

According to Farrell and Ventura (1998:251), and in line with other research, the class of wrong responses resulting from graphological or phonetic interferences, included the following: the word 'consistent' was confused with 'constant', and the word 'principal' was twice confused with 'principle'. The end results is that learners are bound to fail in understanding the meaning of words in a science context.

5.3.4 Lack of precision with the use of words.

Studies have also revealed that lack of precision in the use of words can have negative effects on conceptual development in a science classroom, where learners cannot make clear connections between everyday words and their contextual meaning in science. Oyoo (2009:175) asserts that salient among these included being precise with word meanings or avoiding ambiguity in word use, teachers using simple language in the classrooms, and teachers announcing, at the end of the lesson, the difficult words that were expected in the lessons to follow, so that students could look for their meanings in advance. For example, in both the questionnaire and interview analysis, It was evident that learners did not know the precise meaning of the word "contract", even though they claimed in the interview to know the meaning of the word. Overall 31% of all participating learners did not know the meaning of the word "contract" when used in a science context (see table 4.1). During the interview, learners thought that they understood the meaning of the words, but their explanation revealed that they had drawn their understanding from outside the science environment, as shown by the excerpt below:

R: Ok Thanks. Can we look at the word **'contract'**

R: Are you familiar with this word?

All: Yes

R: Can u explain what it means?

L1: I think to contract means that you are getting smaller

R; Ja

L1: Something when it's cold it gets smaller

R: Any other more understanding?

All: (silence)

R: Tell me, do you use that word in physical sciences?

All: Yes

R: Can you recall the topic?

L2: Ahm…it's waves, longitudinal waves

L3: Yes it's waves sir!

R: What is happen with wave?

L4: When they tell us that maybe the magnitude of the wave or something has contracted (then murmuring)
Thus, it can be concluded that in scientific context, a word does have a different meaning to that found in everyday situations.

5.3.5 Lack of proficiency in the language of teaching and learning.

A necessary first step in all learning, including the learning of science, is attaining acceptable level of proficiency in the language of teaching and learning. For the student, fluency in the related language can lead to a deeper understanding of scientific processes (Maznah & Zurida 2006:75). Logically, learners who communicate better in a language often display a good understanding of scientific concepts, and successfully achieve learning outcomes in science. Learners in some of the schools that were interviewed often code switched to home languages, in order to explain their understanding of certain words during the interview sessions. This showed that the learners lacked the required comprehension to contextually understand concepts taught in a science classroom. A teacher, Ms. P, who was interviewed at school Y, attested to the fact code switching remains a challenge for teachers. In addition, a teacher will code switch to explain a concept in the subject content. The subject following is an excerpt from the interview:
R: Do you think that the answers given by learners who are in a science classroom are influenced by their language background?
Ms. P (see table 3.1): Yes I think the language background is a serious challenge because if you don't know the meaning of the word you cannot utilise that word accordingly but if you have the understanding of the word then it will be much easier you know so if I know the meaning of the word convention from the English class come to science now it's a challenge. Another challenge is code switching because when I am teaching science I must strictly use English so that the learners can get used to it and then when I go to home language I must strictly use home language because these learners battle with their home language do you know that? Reason being code switching when they talk. Even educators code switch when they teach home language, English will come in somewhere. And then same applies when you teach English, a Zulu word will come in so if we

can learn as educators to say let’s focus on a language when we teach, let’s not code switch. When I am teaching a content let me use a relevant language like I am teaching science let me use the scientific language of which is related to English. Yes in class the teacher must explain those English terminologies and lets teach learners how to utilise them showing the understanding of words bring more examples so that the learners can understand and able to interpret application of those words.

R: Thank you very much mam.

Ms. P: Is that all?

R: Yes mam

Ms. P: Okay bhuti (giggling)

To sum up, proficiency in the language of instruction is a key deliverable in addressing the communication and interaction problems in a science classroom. This will foster the understanding of the meaning of everyday words in a science context.

5.3.6 Selecting words whose meaning was opposite to those intended.

In this study, it was found that some learners gave answers whose actual meaning was opposite to the correct answer.

The study re-established that an ‘alarming number’ of students harboured meanings that were the exact opposite to the actual listed examples. These included, amongst others, ‘ refined’ for ‘crude’ , ‘simple’ for ‘complex’ and ‘final’ for ‘initial’ (Farrell & Ventura 1998:245). For example, the question on the word “retard” (question no. 16), which also scored low in the questionnaire (20%) average of correct responses (see Table 4.1), indicated that 62/138 (46%) of all learners gave the opposite meaning i.e. instead of slow down the reaction (B) they chose speed up reaction (A) (see appendices G1-G4).

Most of the learners interviewed on the word indicated that they had heard of this word for the first time in the interview. The excerpts of the interview are as follows:

R: Now I want us to look at the second word ‘**retard’**. Are you familiar with this word?

All: (Some say yes some say no)

L1: I think I have an idea.

R: Ja can you give the idea

L1: I think is to pull something.

R: Do you want to elaborate on that?

L2: Ahm…(no one responds)

R: Ok fine. Is this word normally used in physical sciences?

L3: Well it's rare but yes we do,

R: If so can you remember which topic were you learning about?

L3: I cannot remember exactly

R: So you cannot remember all of you?

All: Yes sir.

The difficulties shown in this situation confirmed that many learners were not equipped with the meanings of everyday words in a science context.

5.4 CONCLUSION

The study was set to explore the learners' understanding of meanings of everyday words when used in science contexts. The summary of the findings, as presented above, is in line with the aims and objectives of the study, as well as the research questions posed. The discussions based on the results obtained from all participating schools affirm the general difficulties in using English language words in specific contexts, especially in the science context. Sources of difficulty in the understanding of meaning in a science context included lack of familiarity with words, confusion with words which sound alike and lack of precision with the use of words as earlier reported in section 5.2. As the study was conducted on a small scale, the findings cannot be generalised. However, they provide insight into typical challenges faced by learners studying science in English as an additional language in South Africa.

5.5 LIMITATION TO THE STUDY

In this study, the following factors are limitations:

Sample

The school participants were Grade 11 physical sciences learners from four township secondary schools in the Gauteng East district. Therefore, the sample is not representative of Grade 11 populations in South Africa. Furthermore, in the study, farm schools[3] around the Gauteng East district could not be invited to participate in the study, because most of these schools did not offer secondary education. If they had been able to participate, a different picture could have been painted because of their environment and socio-economic situation. In addition, the study was carried out at second language schools (in the township[1]), with the results that comparison could not be made, at school level, with a first language school (in the suburbs[2]).

Interview

The interview approach was not comprehensive enough, as answers to other options were not explored, owing to time constraints. Some learners who participated in the study used scholar transport, which leaves early; hence they did not have enough time for different opinions to be explored.

Note

1. The term townships refer to residential areas on the periphery of towns or cities previously reserved for black South Africans.
2. The term suburbs refer to residential areas existing as part of towns or cities previously reserved for white South Africans.

5.6 RECOMMENDATIONS

Despite the size of the sample, which was not large enough for generalising the recommendations broadly, however, the researcher makes the following recommendations to improve science teaching and learning.

- The science teachers should be made aware that science concepts and technical words should be taught alongside everyday words to enhance familiarity with words. This approach recognises the expertise teachers should have in teaching 'everyday' literacies, while providing support for hands-on science (Gluckman 2010:47). For example, before each lesson, the teacher can identify words which will be used mostly during the lesson, write them on the board, and explain to learners how they will be used in explaining the content. Learners will appreciate that the words they are familiar with can be used differently during the lesson. Therefore, such awareness will assist science teachers to explain the meanings of everyday words to learners, in order to improve their understanding of scientific concepts, which will enhance the learning process.

- According to Farrell and Ventura (1998:251), also in line with other research, was the class of wrong responses resulting from graphological or phonetic interference. One of the findings in the study was that learners confused words which sounded alike as was demonstrated during interviews. One of the findings in the study was that learners confused words which sounded alike. Physical sciences teachers in conjunction with teachers from the English department of the school should strive to provide skills of distinguishing words with similar sounds when pronouncing them. Once learners are made aware of contextual differences in the meanings of words with similar sound, they will be in a position to enhance their understanding of how these words can be used differently in a science context.

- There is also a need for awareness to be raised and promoted in the form of school science conferences and workshops, highlighting the difficulties of using words of the instructional language in a science context. Educational planners of the national curriculum need to review and consider the instructional language from early schooling onwards, in order to accumulate more English words, which can be used later in a science context.

5.7 REFLECTIONS

Owing to the researcher's engagement with this study, his approach to teaching has changed, starting with identifying words which he can use during lesson. The researcher will write them on the board and ask the learners to write them down in their notebooks, and show them how they are used in explaining a science concept.

Conducting this study and reporting on its results has been a worthwhile exercise for the researcher. The hiccups and challenges in collecting and analysing data, and other related logistics, have provided me with a valuable opportunity and immense experience, which will guide the researcher in terms of future approaches towards the implementing of a research project.

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APPENDIX A1

Information Sheet for District Director

Request for permission to conduct research at Gauteng East District Secondary Schools.

Title: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools.

To: Gauteng East District: Director's Office

Dear Madam

I, Zamani Lawrance Sithole, am doing research under the supervision of Nkopodi Nkopodi, a professor in the Department of Science and Technology Education, towards my Masters in Education degree at the University of South Africa. We are inviting you to participate in this study, which is entitled "Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools".

The aim of the study is to investigate learners' difficulties in assigning meanings to English language words when used in a science context.

Your school has been selected because of its accessibility and, availability, and because it offers the subject of interest (Physical Sciences).

The study will entail drawing learners' understanding of English words when used in a science context, by requesting them to complete the questionnaire, which probes their word understanding. The interviews with them will be audio recorded, so that they can elaborate on their understanding.

The benefits of this study are that by participating in the study, learners will be able to improve their science vocabulary and the use of science words.

Potential risks are almost non-existent, as learners will only be subjected to filling in the questionnaire by choosing the appropriate answers, and elaborating on their word understanding during the interview.

The feedback procedure will entail a verbal or written statement that is issued to all participants through their schools, which contains a summary of the main findings of the study, as well as a message to thank all the participants for having made this research possible.

Yours sincerely

ZSithole

Zamani Lawrance Sithole
[Researcher]

APPENDIX A2

Information Sheet for Principals

Request for permission to conduct research at your school.

Title: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools.

Dear Principals

I, Zamani Lawrance Sithole, am doing research under the supervision of Nkopodi Nkopodi, a professor in the Department of Science and Technology Education, towards my Masters in Education degree at the University of South Africa. We are inviting you to participate in this study, which is entitled "Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools".

The aim of the study is to investigate learners' difficulties in assigning meanings to English language words when used in a science context.

Your school has been selected because of its accessibility and, availability, and because it offers the subject of interest (Physical Sciences).

The study will entail drawing learners' understanding of English words when used in a science context, by requesting them to complete the questionnaire, which probes their word understanding. The interviews with them will be audio recorded, so that they can elaborate on their understanding.

The benefits of this study are that by participating in the study, learners will be able to improve their science vocabulary and the use of science words.

Potential risks are almost non-existent, as learners will only be subjected to filling in the questionnaire by choosing the appropriate answers, and elaborating on their word understanding during the interview.

The feedback procedure will entail a verbal or written statement that is issued to all participants through their schools, which contains a summary of the main findings of the study, as well as a message to thank all the participants for having made this research possible.

Yours sincerely

ZSithole

Zamani Lawrance Sithole
[Researcher]

APPENDIX A3

Information Sheet for Teachers

Title: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools.

Dear Prospective Participant

My name is Zamani Sithole and I am doing research under the supervision of Nkopodi Nkopodi, a professor in the Department of Science and Technology Education, towards my Masters in Education degree at the University of South Africa. We are inviting you to participate in this study, which is entitled “Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools”.

WHAT IS THE PURPOSE OF THE STUDY?

The study aims to investigate learners’ understanding of selected English words when used in the science context. The researcher expects to collect important information that could help identify causes of language challenges and make suggestions regarding a better approach towards resolving the language problem that, in the researcher’s experience, exists in a science classroom. Furthermore, the study will recommend possible remedies related to word use and understanding, particularly in a science context.

WHY AM I BEING INVITED TO PARTICIPATE?

In the Gauteng East district, we have a Physical Sciences teacher’s forum that occasionally meets for workshops, content training, moderation of learner work, and other meetings that are called by district officials. We also have an opportunity to discuss our own academic work and experiences. Therefore, the researcher had an opportunity to express to colleagues his desire to conduct research at their schools. Four colleagues responded positively, and indicated that they were keen to host the researcher in their schools. Furthermore, these schools were chosen because of their availability and, accessibility, and because they offered the learning area (physical sciences) that this research is focusing on.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Learners' responses to the questionnaire will be marked, and after this, learners will be interviewed in small groups on their understanding of words in the questionnaire. The interview will be audiotaped and field notes will be taken by the researcher. In addition, the teacher will be interviewed to gain insight into his/her opinion on learners' understanding of the words in a science context. The recording of the interview will ensure that as much verbal data as possible is collected. The time given for answering the questionnaire will be about 30 minutes, and a further 20 minutes will be allocated to interview.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participate in it. If you do decide to take part, you will be given this information sheet to keep, and will be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The results obtained in the study will be made available to the schools for possible display in their libraries in order to raise awareness of the challenge facing the entire school community. Furthermore, by participating in the study, learners will be able to improve their science vocabulary and the use of science words.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

It is anticipated that no foreseeable harm or injury will befall any of the participants in this study, as you will only be expected to respond to a pencil and paper questionnaire, and to participate in an oral interview.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Participants will not be required to write their real names on the questionnaire. Instead, code names will be used in the place of the real names. In the focus group interview, participants will only be required to respond to questions based on their understanding of the meanings of words. While every effort will be made by the researcher to ensure that you cannot be connected to the information that you share during the focus group, the researcher cannot guarantee that other participants in the focus group will treat information confidentially. The researcher will, however, encourage all participants to do so. For this reason, it is advised that you do not disclose personal or sensitive information during the focus group interview.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the University of South Africa, in order to be used for future research or academic purposes. If approval is not obtained, hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the researcher's computer.

WILL I RECEIVE PAYMENT OR ANY OTHER INCENTIVES FOR PARTICIPATING IN THIS STUDY?

It is anticipated that participants will incur no financial loss due to participation in this study. Therefore, you will not be rewarded financially.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the University of South Africa and the Gauteng Department of Education. A copy of the approval letter can be obtained from the researcher on request.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact ZL Sithole on 072 799 5750 or fax 011 736 3401. The findings are accessible as soon as the study has been accepted. Should you require any further information or wish to contact the researcher about any aspect of this study, please contact him on 011 736 3401 or sitholezamani@yahoo.com. Should you have any concerns about the way in which the research has been conducted, you may contact Professor Nkopodi at 012 429 4859 or nkopon@unisa.ac.za. Alternatively, contact the research ethics chairperson of the Research Ethics Review Committee of the University of South Africa, Dr Madaleen Claassens, at mcdtc@netactive.co.za.

Thank you for taking time to read this information sheet and for participating in this study.

ZSithole

Zamani Lawrance Sithole

****

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, __________________ (participant name), confirm that the person asking for my consent to take part in this research has told me about the nature, procedure, and potential benefits of the study, as well as the anticipated inconvenience of my participation.

I have read and understood the information about the study, as explained in the information sheet.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be converted into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential.

I agree to the recording of the interview.

Participant Name & Surname (please print)

____

Participant Signature Date

Researcher's Name & Surname (please print): Zamani Lawrance Sithole

ZSithole
____

Researcher's signature Date ________________

APPENDIX A4

Information Sheet for Parents/Guardians

UNISA college of education

Title: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools.

Dear Parent / Guardian

My name is Zamani Sithole and I am doing research under the supervision of Nkopodi Nkopodi, a professor in the Department of Science and Technology Education, towards my Masters in Education degree at the University of South Africa. We are inviting you to participate in this study, which is entitled "Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools".

WHAT IS THE PURPOSE OF THE STUDY?

The study aims to investigate learners' understanding of selected English words when used in the science context. The researcher expects to collect important information that could help identify causes of language challenges and make suggestions regarding a better approach towards resolving the language problem that, in the researcher's experience, exists in a science classroom. Furthermore, the study will recommend possible remedies related to word use and understanding, particularly in a science context.

WHY AM I BEING INVITED TO PARTICIPATE?

In the Gauteng East district, we have a Physical Sciences teacher's forum that occasionally meets for workshops, content training, moderation of learner work, and other meetings that are called by district officials. We also have an opportunity to discuss our own academic work and experiences. Therefore, the researcher had an opportunity to express to colleagues his desire to conduct research at their schools. Four colleagues responded positively, and indicated that they were keen to host the researcher in their schools. Furthermore, these schools were chosen because of their availability and, accessibility, and because they offered the learning area (physical sciences) that this research is focusing on.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Learners' responses to the questionnaire will be marked, and after this, learners will be interviewed in small groups on their understanding of words in the questionnaire. The interview will be audiotaped and field notes will be taken by the researcher. In addition, the teacher will be interviewed to gain insight into his/her opinion on learners' understanding of the words in a science context. The recording of the interview will ensure that as much verbal data as possible is collected. The time given for answering the questionnaire will be about 30 minutes, and a further 20 minutes will be allocated to interview.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participate in it. If you do decide to take part, you will be given this information sheet to keep, and will be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The results obtained in the study will be made available to the schools for possible display in their libraries in order to raise awareness of the challenge facing the entire school community. Furthermore, by participating in the study, learners will be able to improve their science vocabulary and the use of science words.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

It is anticipated that no foreseeable harm or injury will befall any of the participants in this study, as you will only be expected to respond to a pencil and paper questionnaire, and to participate in an oral interview.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Participants will not be required to write their real names on the questionnaire. Instead, code names will be used in the place of the real names. In the focus group interview, participants will only be required to respond to questions based on their understanding of the meanings of words. While every effort will be made by the researcher to ensure that you cannot be connected to the information that you share during the focus group, the researcher cannot guarantee that other participants in the focus group will treat information confidentially. The researcher will, however, encourage all participants to do so. For this reason, it is advised that you do not disclose personal or sensitive information during the focus group interview.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the University of South Africa, in order to be used for future research or academic purposes. If approval is not obtained, hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the researcher's computer.

WILL I RECEIVE PAYMENT OR ANY OTHER INCENTIVES FOR PARTICIPATING IN THIS STUDY?

It is anticipated that participants will incur no financial loss due to participation in this study. Therefore, you will not be rewarded financially.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the University of South Africa and the Gauteng Department of Education. A copy of the approval letter can be obtained from the researcher on request.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact ZL Sithole on 072 799 5750 or fax 011 736 3401. The findings are accessible as soon as the study has been accepted. Should you require any further information or wish to contact the researcher about any aspect of this study, please contact him on 011 736 3401 or sitholezamani@yahoo.com. Should you have any concerns about the way in which the research has been conducted, you may contact Professor Nkopodi at 012 429 4859 or nkopon@unisa.ac.za. Alternatively, contact the research ethics chairperson of the Research Ethics Review Committee of the University of South Africa, Dr Madaleen Claassens, at mcdtc@netactive.co.za.

Thank you for taking time to read this information sheet and for participating in this study.

ZSithole

Zamani Lawrance Sithole

****

APPENDIX A5

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, the parent/guardian of ……………………………………………… (child's name) consent to my child taking part in this research on the problems that learners encounter in the use of language in the teaching and learning of Physical Sciences.

I have read and understood the information about the study, as explained in the information sheet.

I understand that my child's participation is voluntary and that he/she is free to withdraw at any time without penalty.

I also agree to the recording of the interview. I understand that the findings of the study will be confidential and that my child's name will not be included in the results, but that a code will instead be assigned.

Parent or Guardian Name & Surname (please print)

____

Parent or guardian Signature Date

____

Researcher's Name & Surname (please print): Zamani Lawrance Sithole

ZSithole
____

Researcher's signature Date ___________________

APPENDIX A6

Information Sheet for Learners

Title: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools.

Dear Learner

My name is Zamani Sithole and I am doing research under the supervision of Nkopodi Nkopodi, a professor in the Department of Science and Technology Education, towards my Masters in Education degree at the University of South Africa. We are inviting you to participate in this study, which is entitled "Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng-East townships secondary schools".

WHAT IS THE PURPOSE OF THE STUDY?

The study aims to investigate learners' understanding of selected English words when used in the science context. The researcher expects to collect important information that could help identify causes of language challenges and make suggestions regarding a better approach towards resolving the language problem that, in the researcher's experience, exists in a science classroom. Furthermore, the study will recommend possible remedies related to word use and understanding, particularly in a science context.

WHY AM I BEING INVITED TO PARTICIPATE?

In the Gauteng East district, we have a Physical Sciences teacher's forum that occasionally meets for workshops, content training, moderation of learner work, and other meetings that are called by district officials. We also have an opportunity to discuss our own academic work and experiences. Therefore, the researcher had an opportunity to express to colleagues his desire to conduct research at their schools. Four colleagues responded positively, and indicated that they were keen to host the researcher in their schools. Furthermore, these schools were chosen because of their availability and, accessibility, and because they offered the learning area (physical sciences) that this research is focusing on.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Learners' responses to the questionnaire will be marked, and after this, learners will be interviewed in small groups on their understanding of words in the questionnaire. The interview will be audiotaped and field notes will be taken by the researcher. In addition, the teacher will be interviewed to gain insight into his/her opinion on learners' understanding of the words in a science context. The recording of the interview will ensure that as much verbal data as possible is collected. The time given for answering the questionnaire will be about 30 minutes, and a further 20 minutes will be allocated to interview.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participate in it. If you do decide to take part, you will be given this information sheet to keep, and will be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The results obtained in the study will be made available to the schools for possible display in their libraries in order to raise awareness of the challenge facing the entire school community. Furthermore, by participating in the study, learners will be able to improve their science vocabulary and the use of science words.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

It is anticipated that no foreseeable harm or injury will befall any of the participants in this study, as you will only be expected to respond to a pencil and paper questionnaire, and to participate in an oral interview.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Participants will not be required to write their real names on the questionnaire. Instead, code names will be used in the place of the real names. In the focus group interview, participants will only be required to respond to questions based on their understanding of the meanings of words. While every effort will be made by the researcher to ensure that you cannot be connected to the information that you share during the focus group, the researcher cannot guarantee that other participants in the focus group will treat information confidentially. The researcher will, however, encourage all participants to do so. For this reason, it is advised that you do not disclose personal or sensitive information during the focus group interview.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the University of South Africa, in order to be used for future research or academic purposes. If approval is not obtained, hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the researcher's computer.

WILL I RECEIVE PAYMENT OR ANY OTHER INCENTIVES FOR PARTICIPATING IN THIS STUDY?

It is anticipated that participants will incur no financial loss due to participation in this study. Therefore, you will not be rewarded financially.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the University of South Africa and the Gauteng Department of Education. A copy of the approval letter can be obtained from the researcher on request.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact ZL Sithole on 072 799 5750 or fax 011 736 3401. The findings are accessible as soon as the study has been accepted. Should you require any further information or wish to contact the researcher about any aspect of this study, please contact him on 011 736 3401 or sitholezamani@yahoo.com. Should you have any concerns about the way in which the research has been conducted, you may contact Professor Nkopodi at 012 429 4859 or nkopon@unisa.ac.za. Alternatively, contact the research ethics chairperson of the Research Ethics Review Committee of the University of South Africa, Dr Madaleen Claassens, at mcdtc@netactive.co.za.

Thank you for taking time to read this information sheet and for participating in this study.

ZSithole
____

Zamani Lawrance Sithole

****

WRITTEN ASSENT

I have read this letter, which invites me to be part of a study conducted at my school. I have understood the information about the study and I know what I will be asked to do. I am willing to be part of the study.

____

Learner's name (print): Learner's signature: Date:

____

APPENDIX B

Information Sheet Ethics Clearance

UNISA | university of south africa

COLLEGE OF EDUCATION RESEARCH ETHICS REVIEW COMMITTEE

14 September 2016

Ref : **2016/09/14/7537565/22/MC**
Student : Mr ZL Sithole
Student Number : 7537565

Dear Mr Sithole

Decision: Approved

Researcher: Mr ZL Sithole
Tel: +2711 736 4615
Email: sitholezamani@yahoo.com

Supervisor: Prof. N Nkopodi
College of Education
Department of Science and Technology Education
Tel: +2712 429 4859
Email: nkopon@unisa.ac.za

Proposal: Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng East townships secondary schools

Qualification: M Ed in Natural Science Education

Thank you for the application for research ethics clearance by the College of Education Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the research.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the College of Education Research Ethics Review Committee on 14 September 2016.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the College of Education Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for*

the research participants.

3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*

Note:

The reference number **2016/09/14/7537565/22/MC** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the College of Education RERC.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof VI McKay
EXECUTIVE DEAN

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX C

Information sheet Permission letter from Gauteng Department of Education

For administrative use only: **Reference no: D2017 / 343** **enquiries: 011 843 6503**

UNITY IN DIVERSITY

GAUTENG PROVINCE

EDUCATION

REPUBLIC OF SOUTH AFRICA

GDE RESEARCH APPROVAL LETTER

Date:	25 October 2016
Validity of Research Approval:	6 February 2017 to 29 September 2017
Name of Researcher:	Sithole Z.L.
Address of Researcher:	20 Chaplan Avenue; Dunnottar; Nigel; 1496
Telephone / Fax Number/s:	011 736 4615; 072 799 5750; 011 736 3401
Email address:	sitholezamani@yahoo.com
Research Topic:	Exploring challenges of everyday English language words in learning Physical Sciences in Gauteng - East Townships Secondary schools.
Number and type of schools:	FOUR Secondary Schools
District/s/HO	Gauteng East

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. *The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.*
2. *The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;*

28/10/2016

APPENDIX D

Information sheet: Interview Schedule for Grade 11 learners

Note: This schedule is for the interview with the learners, after the marking of the items on the questionnaire.

Key: "L" represents the Learner interviewee and "I" stands for the Interviewer I:

I: Good morning boys and girls!

I: We will start by looking at question number 1. Is the word ………………. familiar to you?

L: ……………………………………………………………………………………………

I: What is the reason for your choice for the meaning of the word.…?

L: ……………………………………………………………………………………………

I: Did you come across this word in a Physical Sciences lesson?

L: ………………….…………………………………………………………………...

I: If yes, which topic was being taught?

L: ………………..……………………………………………………………………….

I: How often is the word used in your Physical Sciences class?

L: ……………..………………………………………………………………………….

I: Did the teacher explain its meaning to you?

L: ……………………………………………………………………………………………

I: If so, was the meaning of this word connected to its meaning in the science context?

L: …………………………………………………………………………………………..

I: Do you have any other reason for having selected the answer as the meaning of this word?

L: ………………………………………………………………………………………

APPENDIX E

Information sheet: Interview Schedule for teachers

I: In an interview that was conducted with learners on the use of everyday words in a science classroom, a learner gave a particular meaning of the word …………………………………….. as an answer.

Do you remember using this word …………. in your lesson?

T: ……………………………………………………………………………………

I: Which topic were you teaching?

T: …………………………………………………………………………………

I: Do you think that learners have the same understanding as yours?

T: ……………………………………………………………………………………

I: If the learners did not understand the meaning of the word ……………where do you think the learner might have got the misconception?

T: ..……………………………………………………………………………………

I: Do you think that the answer to the meaning of the word ………… has been influenced by other non-science subjects?

T: ……………………………………………………………………………………

I: Do you think that the answers to science word used in a science classroom, as provided by learners, are influenced by their language background?

T: ……………………………………………………………………………………

I: In your opinion, do you think that there could be any other reason for learners' choice of words as responses?

T: ……………………………………………………………………………………

Thank you for your voluntary participation in the interview

APPENDIX F1

The Questionnaire

Learners' meanings of selected English language words when used in a science context.

(a) Name (Code) …………… (b) Are you Female/Male? Please circle.

(c) Class/Level …… (d) Language used most at

(i) School …………………. (ii) Home ………………………

(e) Parent(s) occupation: ………………………………………

(f) Home assistance with school work (Y or N)

This questionnaire contains questions that are aimed at determining your views about some words used in science classrooms. **It is not a test**, so you need not worry about your answers as being right or wrong. Your responses will be kept very confidential. **Attempt all questions.** After finishing with the questionnaire, drop it immediately in a collection envelope. To record your answers to the questions, please read each question carefully and think about the word that is underlined. Put a CIRCLE round the letter (A, B, C or D) next to the sentence or phrase that you think represents the nearest meaning of the underlined word.

1. The village water supply is contaminated. This means that

   A. Chemicals have been added to make it safe to drink.
   B. It must be cooled before it can be drunk.
   C. It contains micro-organisms and is not safe to drink.
   D. It is enough to let it settle before it can be drunk.

2. When the stone is lowered into a beaker of water, it displaces some of the water. This means it

   A. Reacts with some of the water.
   B. Simply falls through the water to the bottom of the beaker.
   C. Gets bigger.
   D. Pushes away some of the water.

3. If you are asked to describe how you to prepare oxygen, it means you are to say

    A. How it is made.
    B. What it is used for.
    C. How it behaves.
    D. What substances are needed to make it.

4. The child is dehydrated. This means it

    A. Has just drunk a lot of water.
    B. Has too much water in its body.
    C. Has the right amount of water in its body.
    D. Has not enough of water in its body.

5. During some chemical reactions, heat is generated. This means that heat is

    A. Produced.
    B. Gained.
    C. Is lost.
    D. Is not needed.

6. The thermos flask is a useful device for keeping hot liquids. This means it is

    A. A luxury.
    B. An appliance.
    C. A method.
    D. An opportunity.

7. Oil that is found in the earth is called crude oil. This means it is

    A. Refined
    B. Exceptional
    C. Finished
    D. Natural

8. The electrician fits the water heater in the most <u>efficient</u> position. This means she fits it in

   A. The easiest position
   B. The commonest position
   C. The best position
   D. The least likely position

9. The temperature of the liquid was <u>constant</u>. This means it was

   A. Increasing
   B. Decreasing
   C. Not increasing or decreasing
   D. Increasing and decreasing at different times

10. The experiment was designed to prove that the brass rod would <u>contract</u> as the temperature fell. This means the rod would

   A. Change colour
   B. Slacken
   C. Become longer
   D. Become smaller

11. The teacher felt that the learners' interpretation of experimental results was <u>valid</u>. This means the teacher felt it was

   A. Worthless
   B. Not correct
   C. Brief
   D. Sound

12. The two chemicals seemed to combine in a <u>spontaneous</u> reaction. This means the reaction

   A. Was very quick
   B. Was explosive
   C. Once started increased vigorously
   D. Happened by itself

13. The outcome of the chemical reaction depended on many factors. This means that it depended on.

    A. The method
    B. Influences
    C. Systems
    D. Accomplishments

14. The learner's concept of chemical bonding improved when he worked through many exercises. This means the learner's

    A. Idea improved
    B. Design improved
    C. Issue improved
    D. Method improved

15. The car's movement was linear. This means the car

    A. Kept stopping and starting
    B. Moved in a straight line
    C. Was dangerous
    D. Swerved from side to side

16. The learner was trying to find a chemical that would retard the reaction. This means the chemical would

    A. Speed up the reaction
    B. Slow down the reaction
    C. Make the reaction go the other way
    D. Give maximum yield from the reaction

17. If you were asked to find the effect of adding acid to a metal, this means you would try to find

    A. The reason for adding the acid
    B. What happened
    C. How long the reaction took
    D. The quantity of acid used

18. The results of three experiments were consistent. This means the results were

A. Variable
B. Adequate
C. The same
D. Adjusted

19. By convention, when writing a chemical formula, the symbol of a metal is usually written first. This means that this way of writing

A. Is a result of a chemical formula
B. Has been accepted as an agreed practice
C. Was developed as metals were discovered first
D. Has been arrived at but is still the subject of controversy

20. After studying the various conditions that may be affecting the quantity of solid produced from the reaction, the pupil concluded that the effect of pressure was negligible. This means that the learner felt that pressure

A. Need not be taken into account
B. Was the most important factor
C. Was the only factor operating
D. Was the first factor to operate

21. Your science teacher said that she was going to evacuate the flask. This means the teacher will

A. Empty the flask
B. Close the flask
C. Clean the flask
D. Cool it in a vacuum

22. The students were able to estimate the volume of water in the container. This means they

A. They made a careful guess of a volume
B. Measured the volume carefully
C. Poured out some water from the container
D. Filled the container from the tap

23. People are asked to switch off light whenever they leave the room in order to conserve energy. This means people are asked

A. To use energy carefully to make it last
B. To make light brighter on switching on again
C. To avoid risk of a fire
D. Not to make use of a light at all

24. The tube may disintegrate when the reacting gases are released into it. This means the tube may

A. Be seen to glow
B. Change colour
C. Break up into small pieces
D. Collapse in on itself

25. The teacher referred to the motion of the solid particles suspended in the water as random. This means that the motion

A. Was very fast

B. Was starting and stopping

C. Had no order at all

D. Occurred every ten seconds

Thank you for taking time to complete this questionnaire

APPENDIX F2

Memorandum to the Questionnaire

1. The village water supply is contaminated. This means that

   C. It contains micro-organisms and is not safe to drink.

2. When the stone is lowered into a beaker of water, it displaces some of the water. This means it

   D. Pushes away some of the water.

3. If you are asked to describe how you to prepare oxygen, it means you are to say

   A. How it is made.

4. The child is dehydrated. This means it

   E. Has not enough of water in its body.

5. During some chemical reactions, heat is generated. This means that heat is

   A. Produced.

6. The thermos flask is a useful device for keeping hot liquids. This means it is

   B. An appliance.

7. Oil that is found in the earth is called crude oil. This means it is

   D. Natural

8. The electrician fits the water heater in the most efficient position. This means she fits it in

   C. The best position

9. The temperature of the liquid was constant. This means it was

   C. Not increasing or decreasing

10. The experiment was designed to prove that the brass rod would contract as the temperature fell. This means the rod would

    D. Become smaller

11. The teacher felt that the learners' interpretation of experimental results was valid. This means the teacher felt it was

    D. Sound

12. The two chemicals seemed to combine in a spontaneous reaction. This means the reaction

    E. Happened by itself

13. The outcome of the chemical reaction depended on many factors. This means that it depended on

    B. Influences

14. The learner's concept of chemical bonding improved when he worked through many exercises. This means the learner's

    A. Idea improved

15. The car's movement was linear. This means the car

    B. Moved in a straight line

16. The learner was trying to find a chemical that would retard the reaction. This means the chemical would

    B. Slow down the reaction

17. If you were asked to find the effect of adding acid to a metal, this means you would try to find

    B. What happened

18. The results of three experiments were consistent. This means the results were

    C. The same

19. By convention, when writing a chemical formula, the symbol of a metal is usually written first. This means that this way of writing

    B. Has been accepted as an agreed practice

20. After studying the various conditions that may be affecting the quantity of solid produced from the reaction, the pupil concluded that the effect of pressure was negligible. This means that the learner felt that pressure

    A. Need not be taken into account

21. Your science teacher said that she was going to evacuate the flask. This means the teacher will

    A. Empty the flask

22. The students were able to estimate the volume of water in the container. This means they

    A. They made a careful guess of a volume

23. People are asked to switch off light whenever they leave the room in order to conserve energy. This means people are asked

    A. To use energy carefully to make it last

24. The tube may disintegrate when the reacting gases are released into it. This means the tube may

    C. Break up into small pieces

25. The teacher referred to the motion of the solid particles suspended in the water as random. This means that the motion

    C. Had no order at al

APPENDIX G1

Distribution of scores on the correct items versus the incorrect answers for school W

			PARTICIPANTS (N=43)																							
No.	Word	E	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 10	W 11	W 12	W 13	W 14	W 15	W 16	W 17	W 18	W 19	W 20	W 21	W 22	W 23	W 24	W 25	W 26	W 27
1.	Contaminated	C	A	✓	A	A	✓	✓	✓	✓	✓	✓	✓	✓	B	A	A	B	✓	✓	✓	A	✓	✓	✓	A	A
2.	Displaces	D	B	B	B	✓	B	B	B	B	B	B	B	B	✓	B	B	B	✓	✓	✓	✓	B	✓	✓	B	✓
3.	Prepare	A	B	D	D	✓	D	D	✓	B	D	D	✓	D	✓	D	D	B	D	D	D	✓	D	D	✓	D	D
4.	Dehydrate	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5.	Generate	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	D	✓	✓	B	✓	✓	B	✓	B	✓	D	✓	B
6.	Device	B	✓	✓	C	✓	✓	A	✓	✓	A	A	✓	A	C	A	✓	A	✓	C	C	C	✓	C	✓	A	✓
7.	Crude	D	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	✓	✓
8.	Efficient	C	B	✓	A	✓	✓	✓	D	D	✓	D	✓	✓	✓	B	✓	B	✓	✓	B	B	D	✓	✓	✓	✓
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	D	✓	✓	✓	D	✓	✓	✓	✓	✓
10.	Contract	D	C	C	B	✓	B	B	B	A	B	C	✓	A	C	A	A	A	B	✓	B	B	B	✓	B	A	C
11.	Valid	D	B	A	✓	✓	C	B	B	A	C	C	C	A	A	C	A	A	✓	B	A	A	A	C	B	B	C
12.	Spontaneous	D	B	A	B	A	C	A	C	A	B	✓	✓	✓	B	B	A	C	C	A	C	B	A	A	✓	A	A
13.	Factors	B	C	D	A	✓	A	A	C	A	A	D	A	D	✓	A	C	C	A	✓	D	A	✓	✓	D	A	A
14.	Concept	A	✓	✓	C	C	D	✓	✓	✓	D	✓	✓	✓	C	✓	✓	D	✓	✓	✓	B	✓	✓	✓	✓	✓
15.	Linear	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16.	Retard	B	A	A	D	✓	A	C	D	C	A	A	A	A	A	✓	D	✓	A	D	D	D	A	A	C	A	D
17.	Effect	B	A	A	A	A	A	C	D	A	A	A	✓	✓	B	D	C	D	C	✓	A	C	✓	✓	✓	A	✓
18.	Consistent	C	A	✓	✓	✓	A	✓	A	✓	A	✓	D	✓	D	B	A	A	✓	✓	D	A	✓	B	A	✓	✓
19.	Convention	B	A	✓	A	A	✓	A	A	✓	A	A	A	A	C	✓	A	✓	A	A	C	A	C	A	A	A	✓
20.	Negligible	A	✓	B	B	C	✓	C	C	C	C	C	D	B	B	B	✓	D	✓	D	D	B	C	✓	B	B	C
21.	Evacuate	A	✓	✓	✓	✓	D	C	D	✓	✓	C	✓	✓	B	✓	D	B	✓	✓	N	B	✓	✓	B	D	B
22.	Estimate	A	B	✓	B	✓	B	N	B	B	✓	B	B	✓	C	B	B	D	✓	B	N	✓	✓	✓	✓	B	✓
23.	Conserve	A	B	✓	✓	✓	✓	B	D	✓	✓	✓	✓	✓	✓	N	C	✓	✓	✓	N	✓	✓	✓	✓	✓	C
24.	Disintegrate	C	B	A	B	B	✓	B	A	✓	B	B	D	D	D	A	✓	✓	B	✓	N	B	B	✓	✓	✓	D
25.	Random	C	A	✓	✓	✓	✓	B	✓	✓	A	B	B	✓	B	✓	B	B	C	D	N	✓	A	D	A	A	B
	CORRECT		9	15	10	18	13	9	9	14	10	10	15	15	8	10	10	7	16	16	7	9	13	16	15	10	12
	INCORRECT		16	10	15	7	12	15	16	11	15	15	10	10	17	14	15	18	9	9	13	16	12	9	10	15	13
	GENDER		M	M	F	F	F	F	M	M	F	NG	F	NG	M	M	M	M	M	NG	M	F	M	M	M	F	M

Keys

✓ = correct

NG = no gender indicated

No. = Question number

E = Expected answer

N = no response

			PARTICIPANTS (N=43)																		Word Scores	
No.	Word	E	W 28	W 29	W 30	W 31	W 32	W 33	W 34	W 35	W 36	W 37	W 38	W 39	W 40	W 41	W 42	W 48	W 49	W 50	Correct	Incorrect
1.	Contaminated	C	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	31 (72%)	12 (28%)
2.	Displaces*	D	A	✓	B	✓	B	✓	B	✓	B	✓	✓	A	C	A	✓	B	B	A	16 (37%)	27(63%)
3.	Prepare*	A	D	D	✓	B	D	D	B	D	D	B	N	D	✓	✓	B	D	D	D	9(21%)	33(79%)
4.	Dehydrate	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	43(100%)	0(0%)
5.	Generate	A	B	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	D	B	32(74%)	11(26%)
6.	Device	B	✓	✓	✓	✓	D	✓	C	✓	✓	✓	✓	✓	C	✓	C	C	C	C	23(53%)	20(47%)
7.	Crude	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	A	39(91%)	4(9%)
8.	Efficient	C	✓	✓	D	B	B	✓	B	B	✓	✓	B	✓	B	B	✓	D	B	A	22(51%)	21(49%)
9.	Constant	C	D	✓	✓	D	B	✓	A	✓	✓	✓	✓	B	A	✓	✓	B	✓	✓	34(79%)	9(21%)
10.	Contract*	D	A	A	B	A	A	✓	✓	C	A	B	C	B	B	B	A	A	A	A	6(14%)	37(86%)
11.	Valid*	D	B	✓	✓	A	B	C	C	B	C	C	C	A	B	C	B	A	B	B	5(12%)	38(88%)
12.	Spontaneous*	D	B	A	C	B	B	B	A	A	C	A	✓	A	B	B	B	✓	✓	A	7(16%)	36(84%)
13.	Factors*	B	A	✓	A	C	A	✓	A	✓	✓	A	✓	A	D	✓	A	C	D	✓	12(30%)	31(70%)
14.	Concept	A	D	✓	C	✓	D	✓	B	D	✓	D	✓	D	✓	✓	D	D	B	✓	26(60%)	17(40%)
15.	Linear	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	41(95%)	2(5%)
16.	Retard*	B	D	D	D	A	A	✓	✓	A	A	A	A	D	✓	A	A	D	C	D	6(14%)	37(86%)
17.	Effect*	B	✓	✓	A	✓	A	✓	A	✓	A	✓	✓	D	D	✓	✓	D	A	A	16(37%)	27(63%)
18.	Consistent*	C	A	✓	✓	A	B	B	D	A	A	A	✓	✓	A	B	✓	B	A	A	17(40%)	26(60%)
19.	Convention*	B	C	A	✓	A	A	✓	A	✓	A	A	✓	A	A	A	A	✓	C	A	11(26%)	32(74%)
20.	Negligible*	A	D	B	✓	B	B	✓	C	B	✓	B	✓	D	C	D	C	N	✓	C	10(24%)	32(76%)
21.	Evacuate	A	✓	B	✓	D	✓	✓	✓	✓	✓	✓	✓	✓	C	C	D	✓	✓	D	25(60%)	17(40%)
22.	Estimate*	A	B	B	C	B	✓	✓	B	D	✓	✓	✓	B	B	B	B	B	B	✓	15(37%)	26(63%)
23.	Conserve	A	B	B	✓	B	✓	D	✓	✓	✓	✓	✓	✓	B	✓	D	✓	✓	D	29(71%)	12(29%)
24.	Disintegrate	C	✓	✓	✓	✓	A	B	A	✓	✓	✓	✓	A	B	✓	✓	✓	B	✓	20(48%)	22(52%)
25.	Random*	C	A	A	✓	A	A	D	✓	B	✓	A	✓	A	A	A	D	B	B	A	13(31%)	29(69%)
	CORRECT		9	15	16	8	8	17	10	14	16	13	20	9	8	13	10	9	9	8		
	INCORRECT		16	10	9	17	17	8	15	11	9	12	5	16	17	12	15	16	16	17		
	GENDER		F	M	M	F	F	M	F	F	F	F	M	M	F	F	F	F	F	F	∑F=21	∑M=19

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

* = difficult words

Distribution of total % scores per learner and mean % in the questionnaire for school W

CODE	% CORRECT	% INCORRECT
W1	36	64
W2	60	40
W3	40	60
W4	72	28
W5	52	48
W6	36	64
W7	36	64
W10	56	44
W11	40	60
W12	40	60
W13	60	40
W14	60	40
W15	32	68
W16	40	60
W17	40	60
W18	28	72
W19	64	36
W20	64	36
W21	28	72
W22	36	64
W23	52	48
W24	64	36
W25	60	40
W26	40	60
W27	48	52
W28	36	64
W29	60	40
W30	64	36
W31	32	68
W32	32	68
W33	68	32
W34	40	60
W35	56	44
W36	64	36
W37	52	48
W38	80	20
W39	36	64
W40	32	68
W41	52	48
W42	40	60
W48	36	64
W49	36	64
W50	32	68
TOTAL	2032	2268
MEAN	47%	53%

APPENDIX G2

Distribution of scores on the correct items versus the incorrect answers for school X

			PARTICIPANTS (N=26)																							
No.	Word	E	X 1	X 2	X 3	X 4	X 5	X 6	X 7	X 8	X 9	X 10	X 11	X 12	X 13	X 14	X 15	X 16	X 17	X 18	X 19	X 20	X 21	X 22	X 23	X 24	X 25
1.	Contaminated	C	✓	A	✓	✓	✓	✓	✓	✓	A	B	✓	✓	A	A	A	✓	✓	B	D	A	✓	✓	A	✓	✓
2.	Displaces	D	B	✓	✓	✓	B	✓	B	B	C	✓	A	✓	✓	✓	✓	B	B	✓	B	✓	✓	✓	A	✓	A
3.	Prepare	A	✓	D	✓	✓	B	D	D	✓	D	D	D	B	✓	D	D	D	B	✓	✓	D	✓	B	D	N	D
4.	Dehydrate	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5.	Generate	A	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	B	B	✓	✓	✓	C	B	✓	✓	✓	✓	✓	✓	B	C
6.	Device	B	✓	✓	✓	✓	C	A	C	✓	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	✓	✓	✓	C	C	✓	✓
7.	Crude	D	✓	✓	✓	✓	✓	A	✓	✓	✓	A	A	✓	A	✓	✓	A	A	✓	✓	A	✓	✓	✓	✓	✓
8.	Efficient	C	✓	✓	✓	✓	✓	✓	B	✓	✓	A	B	✓	✓	B	B	✓	✓	D	D	✓	A	✓	A	✓	B
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10.	Contract	D	C	✓	C	✓	C	A	✓	✓	C	A	A	A	A	C	✓	A	B	✓	B	✓	✓	B	A	✓	A
11.	Valid	D	C	C	C	✓	C	✓	C	✓	A	✓	✓	C	B	C	C	B	C	B	A	C	C	C	B	C	C
12.	Spontaneous	D	A	A	A	✓	C	A	A	A	A	A	✓	A	A	B	A	A	A	B	C	A	A	✓	B	✓	A
13.	Factors	B	✓	C	A	✓	✓	C	✓	✓	✓	A	A	A	C	✓	A	C	✓	C	A	✓	✓	A	A	D	✓
14.	Concept	A	D	D	✓	✓	✓	D	D	✓	✓	D	✓	C	D	✓	D	D	D	D	✓	✓	✓	D	✓	✓	✓
15.	Linear	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16.	Retard	B	A	A	✓	D	C	✓	A	C	✓	C	A	A	A	✓	B	A	A	A	D	C	C	✓	A	✓	D
17.	Effect	B	A	✓	✓	✓	✓	✓	✓	A	A	D	D	A	C	D	✓	A	D	✓	✓	✓	✓	D	A	✓	✓
18.	Consistent	C	✓	✓	✓	✓	B	✓	✓	✓	B	B	D	A	B	D	B	A	B	✓	✓	B	B	✓	✓	✓	A
19.	Convention	B	A	C	D	A	A	D	C	A	C	A	A	C	D	C	A	A	A	C	C	C	C	C	A	✓	C
20.	Negligible	A	✓	D	✓	B	✓	✓	✓	✓	C	✓	B	✓	✓	B	✓	✓	✓	C	✓	C	✓	✓	B	✓	✓
21.	Evacuate	A	D	✓	✓	D	✓	✓	C	✓	D	✓	✓	D	C	D	✓	C	✓	✓	✓	✓	C	✓	C	✓	✓
22.	Estimate	A	✓	✓	✓	✓	B	✓	✓	✓	✓	B	✓	✓	✓	✓	✓	B	✓	✓	✓	✓	✓	✓	B	✓	B
23.	Conserve	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	D	✓	✓	✓
24.	Disintegrate	C	✓	D	✓	D	B	A	✓	D	✓	✓	✓	✓	B	D	B	B	A	✓	D	✓	✓	B	A	B	D
25.	Random	C	D	✓	✓	✓	✓	D	✓	D	✓	D	B	✓	✓	D	✓	B	B	B	✓	✓	✓	✓	A	✓	✓
	CORRECT		15	15	20	20	13	15	14	18	14	11	12	13	11	12	14	8	11	15	15	16	18	15	8	20	13
	INCORRECT		10	10	5	5	12	10	11	7	11	14	13	12	14	13	11	17	14	10	10	9	7	10	17	5	12
	GENDER		F	F	M	M	F	M	M	M	F	F	F	M	M	F	M	M	M	M	M	M	F	F	F	M	M

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

			Part.	Word Scores	
No.	Word	E	X26	Correct	Incorrect
1.	Contaminated	C	A	15(58%)	11(42%)
2.	Displaces	D	✓	16(62%)	10(38%)
3.	Prepare**	A	D	8(32%)	17(68%)
4.	Dehydrate	D	✓	26(100%)	0(0%)
5.	Generate	A	✓	19(73%)	7(27%)
6.	Device	B	✓	20(77%)	6(23%)
7.	Crude	D	✓	19(73%)	7(27%)
8.	Efficient	C	✓	16(62%)	10(38%)
9.	Constant	C	✓	26(100%)	0(0%)
10.	Contract*	D	A	9(35%)	17(65%)
11.	Valid*	D	C	5(19%)	21(81%)
12.	Spontaneous*	D	✓	5(19%)	21(81%)
13.	Factors*	B	C	10(38%)	16(62%)
14.	Concept	A	N	13(52%)	12(48%)
15.	Linear	B	N	25(100%)	0(0%)
16.	Retard*	B	N	6(24%)	19(76%)
17.	Effect	B	N	13(52%)	12(48%)
18.	Consistent	C	N	12(48%)	13(52%)
19.	Convention*	B	N	1(4%)	24(96%)
20.	Negligible	A	N	17(68%)	8(32%)
21.	Evacuate	A	✓	16(62%)	10(38%)
22.	Estimate	A	✓	21(81%)	5(19%)
23.	Conserve	A	✓	25(96%)	1(4%)
24.	Disintegrate	C	✓	11(42%)	15(58%)
25.	Random	C	✓	16(62%)	10(38%)
	CORRECT		13		
	INCORRECT		12		
	GENDER		M	∑F=10	∑M=16

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = question number

E = expected answer

N = no response

*** = difficult words**

Distribution of total % scores per learner and mean % in the questionnaire for school X

CODE	% CORRECT	% INCORRECT
X1	60	40
X2	60	40
X3	80	20
X4	80	20
X5	56	44
X6	60	40
X7	56	44
X8	72	28
X9	56	44
X10	44	56
X11	48	52
X12	52	48
X13	44	56
X14	48	52
X15	56	44
X16	32	68
X17	44	56
X18	60	40
X19	60	40
X20	64	36
X21	72	28
X22	60	40
X23	32	68
X24	80	20
X25	52	48
X26	52	48
TOTAL	1480	1120
MEAN	57%	43%

APPENDIX G3

Distribution of scores on the correct items versus the incorrect answers for school Y

			PARTICIPANTS (N=34)																							
No.	Word	E	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20	Y 21	Y 22	Y 23	Y 24	Y 25
1.	Contaminated	C	D	✓	✓	✓	A	✓	✓	✓	✓	B	✓	A	✓	A	✓	✓	✓	✓	✓	✓	D	D	✓	A	A
2.	Displaces	D	B	B	B	✓	✓	✓	✓	B	B	✓	B	B	✓	B	B	✓	✓	B	B	B	✓	A	✓	B	✓
3.	Prepare	A	D	D	D	✓	D	✓	✓	D	B	D	✓	B	B	✓	D	C	✓	✓	D	D	D	D	D	D	D
4.	Dehydrate	D	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5.	Generate	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	B	B	B	✓	B	B	C	B	✓	B	✓	✓	✓
6.	Device	B	✓	✓	✓	C	C	C	✓	A	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7.	Crude	D	✓	✓	✓	✓	✓	✓	N	✓	B	✓	N	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	✓	✓
8.	Efficient	C	B	✓	✓	✓	D	✓	B	✓	A	✓	✓	✓	B	✓	✓	✓	N	✓	✓	✓	D	A	✓	D	✓
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	D	✓
10.	Contract	D	✓	✓	✓	✓	✓	A	A	A	✓	C	C	A	✓	A	C	✓	C	C	A	✓	✓	A	✓	B	✓
11.	Valid	D	B	✓	✓	B	B	B	C	C	C	C	A	C	C	A	A	C	C	A	A	C	C	C	✓	B	C
12.	Spontaneous	D	✓	✓	✓	N	✓	A	A	B	B	A	✓	C	C	C	✓	✓	C	✓	B	B	✓	A	C	B	C
13.	Factors	B	C	✓	✓	A	D	A	A	C	✓	A	C	✓	D	D	A	C	C	C	A	A	D	✓	✓	A	A
14.	Concept	A	N	✓	✓	D	✓	✓	D	D	✓	✓	D	D	✓	✓	✓	D	D	D	C	✓	D	✓	✓	C	✓
15.	Linear	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16.	Retard	B	✓	✓	✓	D	A	A	A	A	C	A	A	C	C	C	✓	A	C	✓	A	A	A	✓	A	C	C
17.	Effect	B	A	✓	✓	✓	D	D	✓	A	A	✓	A	✓	A	D	C	✓	✓	A	A	A	✓	A	✓	B	✓
18.	Consistent	C	✓	✓	D	✓	A	B	✓	B	✓	✓	✓	A	B	✓	A	B	✓	✓	D	✓	✓	✓	✓	✓	✓
19.	Convention	B	✓	✓	✓	A	A	A	A	A	C	C	A	D	D	✓	A	A	C	A	C	C	C	✓	C	C	A
20.	Negligible	A	✓	✓	✓	✓	C	✓	✓	✓	C	C	✓	✓	✓	C	✓	C	✓	✓	✓	✓	✓	B	✓	B	B
21.	Evacuate	A	✓	✓	✓	✓	✓	B	D	C	D	✓	C	D	C	✓	C	✓	D	C	B	✓	C	✓	✓	C	✓
22.	Estimate	A	✓	✓	✓	B	B	✓	✓	✓	C	✓	✓	✓	B	✓	✓	B	✓	✓	B	B	B	B	✓	✓	✓
23.	Conserve	A	D	✓	✓	✓	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	B	✓	✓	✓	C	✓	✓	N	✓	✓	✓
24.	Disintegrate	C	✓	✓	✓	✓	✓	✓	N	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	A	A	✓
25.	Random	C	✓	✓	✓	✓	✓	A	D	B	A	✓	✓	✓	B	A	D	✓	✓	✓	✓	✓	✓	D	✓	A	✓
	CORRECT		15	23	22	17	13	14	13	11	9	16	14	14	11	14	13	16	15	16	9	15	15	11	20	8	17
	INCORRECT		10	2	3	8	12	11	12	14	16	9	11	11	14	11	12	9	10	9	16	10	10	14	5	17	8
	GENDER		F	F	F	M	M	F	F	F	F	M	F	F	F	F	F	F	F	F	M	M	M	M	M	F	M

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

			PARTICIPANTS (N=34)									Word Scores	
No.	Word	E	Y 26	Y 27	Y 28	Y 29	Y 30	Y 31	Y 32	Y 34	Y 35	Correct	Incorrect
1.	Contaminated	C	✓	A	✓	A	✓	A	A	✓	A	19(56%)	15(44%)
2.	Displaces	D	✓	B	B	B	A	A	B	A	✓	13(38%)	21(62%)*
3.	Prepare	A	✓	D	C	D	B	D	D	B	✓	8(24%)	26(76%)*
4.	Dehydrate	D	✓	✓	✓	✓	B	✓	✓	B	✓	31(91%)	3(9%)
5.	Generate	A	✓	✓	✓	✓	✓	✓	B	B	✓	23(68%)	11(32%)
6.	Device	B	✓	✓	✓	✓	N	✓	✓	C	✓	27(79%)	6(21%)
7.	Crude	D	✓	✓	✓	A	✓	✓	✓	✓	✓	29(91%)	3(9%)
8.	Efficient	C	B	✓	B	✓	N	✓	✓	B	✓	23(68%)	9(32%)
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	A	✓	30(88%)	4(12%)
10.	Contract	D	C	✓	✓	✓	A	C	✓	A	C	18(53%)	16(47%)
11.	Valid*	D	C	B	C	C	N	A	A	A	C	4(12%)	30(88%)
12.	Spontaneous*	D	A	A	B	A	A	B	B	C	✓	10(29%)	24(71%)
13.	Factors*	B	✓	A	A	A	A	A	A	✓	C	7(21%)	27(79%)
14.	Concept	A	✓	B	✓	D	D	B	✓	D	B	15(44%)	18(56%)
15.	Linear	B	✓	✓	✓	✓	✓	✓	✓	✓	C	31(91%)	3(9%)
16.	Retard*	B	A	A	✓	C	A	A	✓	A	✓	10(29%)	24(71%)
17.	Effect*	B	A	A	C	A	C	✓	C	A	A	13(38%)	21(62%)
18.	Consistent	C	B	A	✓	✓	A	✓	N	A	D	20(60%)	13(40%)
19.	Convention*	B	C	A	C	C	A	D	A	A	A	5(15%)	29(81%)
20.	Negligible	A	✓	✓	B	B	✓	✓	C	D	✓	20(59%)	14(41%)
21.	Evacuate	A	✓	D	D	B	N	C	D	C	✓	14(42%)	20(58%)
22.	Estimate	A	✓	C	C	C	B	✓	✓	B	B	29(85%)	15(15%)
23.	Conserve	A	✓	✓	B	D	✓	✓	✓	✓	✓	27(81%)	6(19%)
24.	Disintegrate*	C	A	A	✓	A	D	✓	✓	B	B	9(28%)	24(72%)
25.	Random	C	✓	✓	A	D	A	B	B	✓	✓	20(59%)	14(41%)
	CORRECT		17	11	12	8	7	13	12	6	14		
	INCORRECT		8	14	13	17	18	12	13	19	11		
	GENDER		F	F	M	F	F	M	M	M	M	∑F=20	∑M=14

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

* = difficult words

Distribution of total % scores per learner and mean % in the questionnaire for school Y

CODE	% CORRECT	% INCORRECT
Y1	60	40
Y2	92	8
Y3	88	12
Y4	68	32
Y5	52	48
Y6	56	44
Y7	52	48
Y8	44	56
Y9	36	64
Y10	64	36
Y11	56	44
Y12	56	44
Y13	44	56
Y14	56	44
Y15	52	48
Y16	64	36
Y17	60	40
Y18	64	36
Y19	36	64
Y20	60	40
Y21	60	40
Y22	44	56
Y23	80	20
Y24	32	68
Y25	68	32
Y26	68	32
Y27	44	56
Y28	48	52
Y29	32	68
Y30	28	72
Y31	52	48
Y32	48	52
Y34	24	76
Y35	56	44
TOTAL	1844	1556
MEAN	54%	46%

APPENDIX G4

Distribution of scores on the correct items versus the incorrect answers for school Z

			PARTICIPANTS (N=35)																							
No.	Word	E	Z 1	Z 2	Z 3	Z 4	Z 5	Z 6	Z 7	Z 8	Z 9	Z1 0	Z 11	Z 12	Z 13	Z 14	Z 15	Z 16	Z 17	Z 18	Z 19	Z 20	Z 21	Z 22	Z 23	Z 24	Z 25
1.	Contaminated	C	✓	✓	✓	D	D	A	A	A	A	A	A	A	A	A	✓	A	A	A	✓	A	A	✓	✓	✓	✓
2.	Displaces	D	B	✓	A	✓	✓	B	✓	B	✓	✓	B	B	✓	✓	✓	✓	✓	A	✓	A	B	✓	✓	A	✓
3.	Prepare	A	✓	✓	D	D	D	D	D	✓	✓	D	D	✓	✓	D	D	D	D	D	✓	D	D	C	D	D	✓
4.	Dehydrate	D	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5.	Generate	A	✓	✓	B	✓	✓	✓	✓	B	✓	✓	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	N	✓	✓	B	✓
6.	Device	B	✓	✓	C	✓	✓	✓	✓	A	✓	✓	✓	A	✓	✓	✓	C	✓	✓	C	✓	A	A	✓	✓	✓
7.	Crude	D	✓	✓	✓	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	B
8.	Efficient	C	✓	A	✓	✓	D	✓	✓	✓	D	✓	✓	A	✓	✓	✓	✓	✓	B	N	✓	B	B	✓	✓	✓
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10.	Contract	D	C	✓	✓	✓	B	A	✓	C	N	B	✓	A	C	C	A	C	A	✓	✓	A	C	A	C	✓	B
11.	Valid	D	✓	✓	B	A	C	C	C	C	C	C	C	B	✓	C	C	B	✓	C	C	A	A	C	C	C	C
12.	Spontaneous	D	C	A	A	✓	B	B	A	C	A	B	A	B	✓	C	A	A	✓	B	✓	B	✓	✓	C	A	B
13.	Factors	B	✓	✓	A	A	✓	✓	✓	✓	✓	C	A	C	A	A	✓	C	✓	✓	✓	✓	✓	C	✓	D	✓
14.	Concept	A	✓	✓	✓	✓	C	✓	✓	✓	✓	C	B	✓	✓	C	✓	D	✓	✓	✓	✓	✓	D	✓	✓	D
15.	Linear	B	✓	✓	✓	✓	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16.	Retard	B	C	✓	A	A	A	C	A	✓	A	C	C	A	A	A	A	B	D	A	✓	C	C	✓	C	A	C
17.	Effect	B	✓	✓	A	A	D	N	✓	A	A	✓	A	✓	A	✓	A	✓	✓	A	✓	A	✓	C	✓	✓	✓
18.	Consistent	C	B	✓	B	✓	A	✓	B	✓	✓	B	A	A	✓	A	✓	B	✓	D	✓	A	✓	✓	✓	B	✓
19.	Convention	B	✓	✓	A	C	✓	D	N	D	A	A	C	N	C	C	A	✓	✓	C	✓	D	A	×	✓	A	C
20.	Negligible	A	✓	✓	✓	✓	D	✓	✓	✓	✓	✓	✓	✓	✓	B	B	B	✓	✓	✓	B	B	✓	✓	✓	✓
21.	Evacuate	A	✓	D	D	✓	✓	C	✓	D	C	C	C	C	C	C	✓	✓	B	D	C	C	D	C	✓	✓	C
22.	Estimate	A	✓	✓	B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	✓	✓	B	✓	B	✓	✓	✓
23.	Conserve	A	✓	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	✓
24.	Disintegrate	C	✓	✓	✓	B	✓	D	B	✓	B	D	D	✓	D	✓	✓	✓	✓	✓	✓	✓	B	D	C	D	D
25.	Random	C	✓	✓	A	✓	A	✓	✓	✓	✓	A	✓	A	A	A	D	✓	✓	✓	✓	✓	B	D	✓	✓	D
	CORRECT		20	22	10	17	12	13	17	14	15	11	12	12	15	11	16	14	20	14	20	12	11	12	19	14	15
	INCORRECT		5	3	15	8	13	12	8	11	10	14	13	13	10	14	9	11	5	11	5	13	14	13	6	11	10
	GENDER		F	F	F	M	M	F	M	F	F	F	F	F	F	F	M	M	M	F	F	M	M	M	F	F	F

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

			PARTICIPANTS (N=35)										Word Scores	
No.	Word	E	Z26	Z27	Z28	Z29	Z30	Z31	Z32	Z33	Z34	Z35	Correct	Incorrect
1.	Contaminated	C	✓	A	D	✓	N	✓	A	✓	✓	A	14(41%)	21(59%)
2.	Displaces	D	B	B	✓	✓	B	A	C	✓	A	B	18(51%)	17(49%)
3.	Prepare**	A	D	✓	D	D	D	C	D	D	D	C	9(25%)	26(75%)
4.	Dehydrate	D	✓	✓	✓	✓	C	✓	✓	✓	✓	✓	33(94%)	2(6%)
5.	Generate	A	✓	✓	✓	✓	✓	✓	✓	B	B	✓	28(82%)	6(18%)
6.	Device	B	✓	✓	✓	✓	C	✓	✓	A	✓	C	25(71%)	10(21%)
7.	Crude	D	✓	A	A	✓	✓	✓	✓	A	✓	✓	29(83%)	6(17%)
8.	Efficient	C	B	✓	D	✓	✓	✓	D	✓	✓	✓	24(71%)	10(29%)
9.	Constant	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	34(97%)	1(3%)
10.	Contract*	D	A	C	A	✓	C	✓	A	A	A	B	10(21%)	24(79%)
11.	Valid*	D	C	B	C	C	C	C	C	C	C	C	4(11%)	31(89%)
12.	Spontaneous*	D	C	B	A	C	N	A	B	B	C	A	6(18%)	28(82%)
13.	Factors	B	B	✓	A	✓	C	C	D	A	✓	D	18(51%)	17(49%)
14.	Concept	A	✓	D	D	✓	✓	✓	✓	D	C	D	23(66%)	12(34%)
15.	Linear	B	✓	C	✓	✓	A	✓	D	✓	✓	✓	31(89%)	4(11%)
16.	Retard*	B	C	A	✓	A	A	A	C	C	A	C	5(14%)	30(86%)
17.	Effect	B	✓	A	C	✓	A	A	A	✓	✓	✓	18(53%)	16(47%)
18.	Consistent	C	✓	✓	D	✓	✓	B	A	✓	✓	✓	20(57%)	15(43%)
19.	Convention*	B	✓	A	C	D	A	✓	A	✓	✓	D	11(33%)	22(67%)
20.	Negligible	A	B	C	✓	✓	B	✓	B	✓	✓	B	24(69%)	11(31%)
21.	Evacuate	A	✓	✓	✓	✓	✓	✓	D	C	✓	✓	16(46%)	19(54%)
22.	Estimate	A	✓	✓	✓	✓	✓	✓	B	✓	✓	✓	30(86%)	5(14%)
23.	Conserve	A	✓	C	✓	✓	✓	✓	✓	✓	✓	✓	32(91%)	3(9%)
24.	Disintegrate	C	✓	D	D	B	✓	✓	✓	A	A	B	17(49%)	18(51%)
25.	Random	C	D	✓	✓	✓	✓	✓	B	✓	✓	B	22(63%)	13(37%)
	CORRECT		15	11	12	19	11	17	8	13	16	11		
	INCORRECT		10	14	13	6	14	8	17	12	9	14		
	GENDER		M	M	M	M	F	F	F	M	M	F	∑F=20	∑M=15

Keys

✓ = correct

SYMBOL = preferred incorrect

No. = Question number

E = Expected answer

N = no response

*** = difficult words**

Distribution of total % scores per learner and mean % in the questionnaire for school Z.

CODE	% CORRECT	% INCORRECT
Z1	80	20
Z2	88	12
Z3	40	60
Z4	68	32
Z5	48	52
Z6	52	48
Z7	68	32
Z8	56	44
Z9	60	40
Z10	44	56
Z11	48	52
Z12	48	52
Z13	60	40
Z14	44	56
Z15	64	36
Z16	56	44
Z17	80	20
Z18	56	44
Z19	80	20
Z20	48	52
Z21	44	56
Z22	48	52
Z23	76	24
Z24	56	44
Z25	60	40
Z26	60	40
Z27	44	56
Z28	48	52
Z29	76	24
Z30	44	56
Z31	68	32
Z32	32	68
Z33	52	48
Z34	64	36
Z35	44	56
TOTAL	2004	1496
MEAN	57%	43%

APPENDIX H1

Distribution Table for Grade 11 Physical Sciences learners' profile - School W

.	Code	Gender	Age	Home Language	Assisted with school work	Parent/Guardian Occupation
1.	W1	Male	17	Sesotho	No	Supervisor**
2.	W2	Male	16	Sesotho	No	Mechanic**
3.	W3	Female	16	IsiZulu	No	Social worker*
4.	W4	Female	17	SiSwati	Yes	Unemployed***
5.	W5	Female	17	IsiZulu	No	Stock packer**
6.	W6	Female	17	IsiZulu	No	Unemployed***
7.	W7	Male	19	IsiXhosa	No	Comedian*
8.	W10	Male	17	isiZulu	No	Cashier**
9.	W11	Female	17	IsiZulu	No	Domestic worker**
10.	W12	---------	17	IsiZulu	No	Unemployed***
11.	W13	Female	16	IsiZulu	No	Unemployed***
12.	W14	----------	16	IsiZulu	No	Unemployed***
13.	W15	Male	17	IsiZulu	No	Unemployed***
14.	W16	Male	17	IsiZulu	No	Unemployed***
15.	W17	Male	16	IsiNdebele	No	Store assistant**
16.	W18	Male	17	Sesotho	No	Nurse*
17.	W19	Male	17	IsiZulu	No	Dentist*
18.	W20	----------	15	IsiZulu	---	Police officer*
19.	W21	Male	18	Tsonga	---	---------
20.	W22	Female	18	Sesotho	No	Unemployed***
21.	W23	Male	17	English	No	Police officer*
22.	W24	Male	16	IsiZulu	No	Mechanical engineer*
23.	W25	Male	17	Sesotho	No	Unemployed***
24.	W26	Female	18	IsiZulu	No	Unemployed***
25.	W27	Male	17	Sesotho	No	Customer service*
26.	W28	Female	16	IsiZulu	No	Unemployed***
27.	W29	Male	16	IsiZulu	No	General worker**
28.	W30	Male	17	Sesotho	No	Unemployed***
29.	W31	Female	16	IsiZulu	Yes	Unemployed***
30.	W32	Female	15	Sesotho	Yes	Unemployed***
31.	W33	Male	18	Tshivenda	No	Unemployed***
32.	W34	Female	17	IsiNdebele	No	----------
33.	W35	Female	17	Sesotho	No	Unemployed***
34.	W36	Female	17	Sesotho	No	Unemployed***
35.	W37	Female	17	Sesotho	No	Unemployed***
36.	W38	Male	16	IsiZulu	No	Manager*
37.	W39	Male	18	IsiZulu	No	Unemployed***
38.	W40	Female	16	IsiZulu	No	Unemployed***
39.	W41	Female	17	IsiZulu	No	Unemployed***
40.	W42	Female	16	IsiZulu	Yes	Unemployed***
41.	W48	Female	16	IsiZulu	Yes	Unemployed***
42.	W49	Female	17	Sesotho	No	Unemployed***
43.	W50	Female	16	IsiZulu	No	Unemployed***

Keys
*Professional (9)
**Semi-skilled (6)
***Unemployed (25)

APPENDIX H2

Distribution Table for Grade 11 Physical Sciences learners' profile - School X

No.	Code	Gender	Age	Home Language	Assisted with school work	Parent/Guardian Occupation
1.	X1	Female	17	IsiZulu	No	Unemployed***
2.	X2	Female	18	IsiZulu	Yes	Unemployed***
3.	X3	Male	----	IsiZulu	Yes	Nurse*
4.	X4	Male	17	IsiZulu	Yes	Machine optimizer**
5.	X5	Female	----	IsiZulu	Yes	Unemployed***
6.	X6	Male	18	Sesotho	No	----------
7.	X7	Male	17	IsiZulu	Yes	General worker**
8.	X8	Male	19	IsiZulu	No	Nurse*
9.	X9	Female	16	English	Yes	Self employed**
10.	X10	Female	17	IsiZulu	Yes	Self employed**
11.	X11	Female	17	IsiZulu	---	Unemployed***
12.	X12	Male	17	Sesotho	No	Courier service**
13.	X13	Male	18	Sesotho	Yes	Unemployed***
14.	X14	Female	16	IsiZulu	No	Domestic worker**
15.	X15	Male	16	IsiZulu	Yes	Electrician**
16.	X16	Male	16	Setswana	No	Unemployed***
17.	X17	Male	17	IsiZulu	Yes	Unemployed***
18.	X18	Male	17	IsiZulu	Yes	Cashier**
19.	X19	Male	---	SiSwati	No	Unemployed***
20.	X20	Male	16	IsiZulu	No	Unemployed***
21.	X21	Female	16	IsiZulu	Yes	Liaison officer*
22.	X22	Female	16	Setswana	Yes	Unemployed***
23.	X23	Female	17	Sepedi	No	Security officer**
24.	X24	Male	16	Sesotho	No	Unemployed***
25.	X25	Male	15	Setswana	Yes	-------
26.	X26	Male	15	IsiZulu	Yes	Unemployed***

Keys

*Professional (3)

**Semi-skilled (8)

***Unemployed (12)

APPENDIX H3

Distribution Table for Grade 11 Physical Sciences learners' profile - School Y

No.	Code	Gender	Age	Home Language	Assisted with school work	Parent/Guardian Occupation
1.	Y1	Female	17	IsiZulu	No	Unemployed***
2.	Y2	Female	16	IsiZulu	No	Unemployed***
3.	Y3	Female	17	IsiZulu	No	Unemployed***
4.	Y4	Male	18	IsiZulu	No	Builder**
5.	Y5	Male	18	IsiZulu	No	Domestic worker**
6.	Y6	Female	18	Sesotho	No	Manager*
7.	Y7	Female	19	IsiZulu	No	SANDF*
8.	Y8	Female	18	IsiZulu	No	Manager*
9.	Y9	Female	18	IsiZulu	No	Unemployed***
10.	Y10	Male	17	IsiZulu	No	Domestic worker**
11.	Y11	Female	19	IsiZulu	Yes	Unemployed***
12.	Y12	Female	18	IsiZulu	Yes	Unemployed***
13.	Y13	Female	18	IsiZulu	Yes	Domestic worker**
14.	Y14	Female	17	Sesotho	---	Unemployed***
15.	Y15	Female	18	IsiZulu	No	Domestic worker**
16.	Y16	Female	18	IsiZulu	No	Nurse*
17.	Y17	Female	17	IsiZulu	No	Unemployed***
18.	Y18	Female	18	IsiZulu	No	Domestic worker**
19.	Y19	Male	18	IsiZulu	No	Unemployed***
20.	Y20	Male	18	IsiZulu	No	Nurse*
21.	Y21	Male	18	IsiZulu	No	Manager*
22.	Y22	Male	19	IsiZulu	No	Welder**
23.	Y23	Male	18	Sepedi	No	Learnership**
24.	Y24	Female	18	IsiZulu	Yes	Administrator*
25.	Y25	Male	17	IsiZulu	No	Unemployed***
26.	Y26	Female	19	IsiZulu	No	Unemployed***
27.	Y27	Female	18	IsiZulu	Yes	-----------
28.	Y28	Male	19	Sesotho	---	Receptionist*
29.	Y29	Female	17	IsiZulu	Yes	Unemployed***
30.	Y30	Female	18	IsiZulu	---	--------
31.	Y31	Male	18	Sesotho	---	--------
32.	Y32	Male	18	Sesotho	No	Unemployed***
33.	Y34	Male	18	Sesotho	---	Receptionist*
34.	Y35	Male	18	IsiZulu	Yes	Receptionist*

Keys

*Professional (10)

**Semi-skilled (7)

***Unemployed (13)

APPENDIX H4

Distribution Table for Grade 11 Physical Sciences learners' profile - School Z

No.	Code	Gender	Age	Home Language	Assisted with school work	Parent/Guardian Occupation
1.	Z1	Female	16	Sesotho	No	Driver**
2.	Z2	Female	16	Sepedi	No	Unemployed***
3.	Z3	Female	18	IsiXhosa	---	Unemployed***
4.	Z4	Male	16	IsiXhosa	Yes	-------
5.	Z5	Male	17	IsiZulu	No	-------
6.	Z6	Female	17	IsiZulu	Yes	Unemployed***
7.	Z7	Male	16	IsiXhosa	Yes	Unemployed***
8.	Z8	Female	16	IsiZulu	Yes	Unemployed***
9.	Z9	Female	16	IsiXhosa	Yes	Unemployed***
10.	Z10	Female	15	IsiXhosa	Yes	Unemployed***
11.	Z11	Female	16	IsiZulu	No	Unemployed***
12.	Z12	Female	15	IsiZulu	No	Unemployed***
13.	Z13	Female	16	IsiZulu	Yes	Unemployed***
14.	Z14	Female	17	IsiZulu	Yes	Unemployed***
15.	Z15	Male	16	IsiXhosa	Yes	Teacher*
16.	Z16	Male	17	IsiXhosa	Yes	Merchandiser**
17.	Z17	Male	17	IsiZulu	No	Financial advisor*
18.	Z18	Female	17	IsiNdebele	Yes	Unemployed***
19.	Z19	Female	15	IsiZulu	No	Unemployed***
20.	Z20	Male	17	IsiXhosa	Yes	------
21.	Z21	Male	16	IsiXhosa	No	------
22.	Z22	Male	17	IsiZulu	Yes	Manager*
23.	Z23	Female	15	IsiZulu	Yes	Teacher*
24.	Z24	Female	16	IsiZulu	Yes	-------
25.	Z25	Female	17	IsiZulu	Yes	Unemployed***
26.	Z26	Male	16	IsiZulu	No	Unemployed***
27.	Z27	Male	17	------	No	Teacher*
28.	Z28	Male	16	IsiNdebele	No	Unemployed***
29.	Z29	Male	16	IsiXhosa	No	Unemployed***
30.	Z30	Female	16	IsiZulu	No	Unemployed***
31.	Z31	Female	16	IsiZulu	Yes	Operator**
32.	Z32	Female	19	IsiXhosa	Yes	Teacher*
33.	Z33	Male	16	IsiZulu	Yes	Unemployed***
34.	Z34	Male	17	IsiXhosa	Yes	Receptionist*
35.	Z35	Female	15	Sesotho	Yes	Unemployed***

Keys

*Professional (7)

**Semi-skilled (3)

***Unemployed (20)

APPENDIX I

Distribution Table for Female Learners' Scores

No.	Code	Gender	Scores
1.	W3	Female	40
2.	W4	Female	72
3.	W5	Female	52
4.	W6	Female	36
5.	W11	Female	40
6.	W13	Female	60
7.	W22	Female	36
8.	W26	Female	40
9.	W28	Female	36
10.	W31	Female	32
11.	W32	Female	32
12.	W34	Female	40
13.	W35	Female	56
14.	W36	Female	64
15.	W37	Female	52
16.	W40	Female	32
17.	W41	Female	52
18.	W42	Female	40
19.	W48	Female	36
20.	W49	Female	36
21.	W50	Female	32

No.	Code	Gender	Scores
1.	X1	Female	60
2.	X2	Female	60
3.	X5	Female	56
4.	X9	Female	56
5.	X10	Female	44
6.	X11	Female	48
7.	X14	Female	48
8.	X21	Female	72
9.	X22	Female	60
10.	X23	Female	32

No.	Code	Gender	Scores
1.	Y1	Female	60
2.	Y2	Female	92
3.	Y3	Female	88
4.	Y6	Female	56
5.	Y7	Female	52
6.	Y8	Female	44
7.	Y9	Female	36
8.	Y11	Female	56
9.	Y12	Female	56
10.	Y13	Female	44
11.	Y14	Female	56
12.	Y15	Female	52
13.	Y16	Female	64
14.	Y17	Female	60
15.	Y18	Female	64
16.	Y24	Female	32

1.	Z1	Female	80
2.	Z2	Female	88
3.	Z3	Female	40
4.	Z6	Female	52
5.	Z8	Female	56
6.	Z9	Female	60
7.	Z10	Female	44
8.	Z11	Female	48
9.	Z12	Female	48
10.	Z13	Female	60
11.	Z14	Female	44
12.	Z18	Female	56
13.	Z19	Female	80
14.	Z23	Female	76
15.	Z24	Female	56
16.	Z25	Female	60
17.	Z30	Female	44
18.	Z31	Female	68
19.	Z32	Female	32
20.	Z35	Female	44
TOTAL			3672
MEAN			51.7%

17.	Y26	Female	68
18.	Y27	Female	44
19.	Y29	Female	32
20.	Y30	Female	28

APPENDIX J

Distribution Table Male Learners' Scores

No.	Code	Gender	Scores
1.	W1	Male	36
2.	W2	Male	60
3.	W7	Male	36
4.	W10	Male	56
5.	W15	Male	32
6.	W16	Male	40
7.	W17	Male	40
8.	W18	Male	28
9.	W19	Male	64
10.	W21	Male	28
11.	W23	Male	52
12.	W24	Male	64
13.	W25	Male	60
14.	W27	Male	48
15.	W29	Male	60
16.	W30	Male	64
17.	W33	Male	68
18.	W38	Male	80
19.	W39	Male	36

No.	Code	Gender	Scores
1.	X3	Male	80
2.	X4	Male	80
3.	X6	Male	60
4.	X7	Male	56
5.	X8	Male	72
6.	X12	Male	52
7.	X13	Male	44
8.	X15	Male	56
9.	X16	Male	32
10.	X17	Male	44
11.	X18	Male	60
12.	X19	Male	60
13.	X20	Male	64
14.	X24	Male	80
15.	X25	Male	52
16.	X26	Male	52

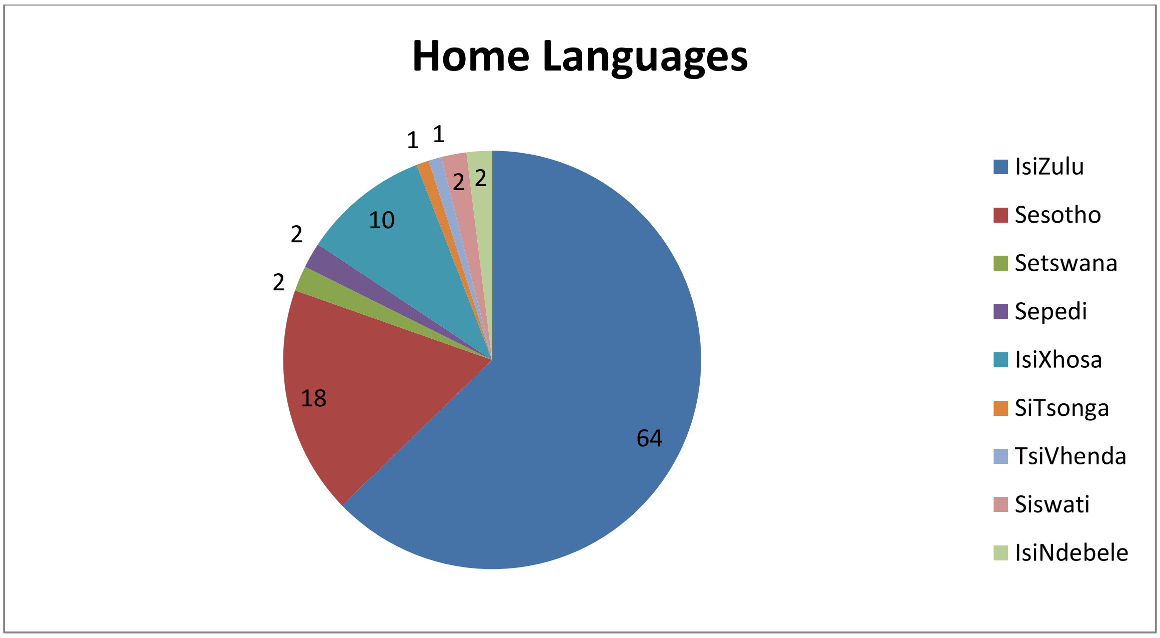
No.	Code	Gender	Scores
1.	Y4	Male	68
2.	Y5	Male	52
3.	Y10	Male	64
4.	Y19	Male	36
5.	Y20	Male	60
6.	Y21	Male	60
7.	Y22	Male	44
8.	Y23	Male	80
9.	Y25	Male	68
10.	Y28	Male	48
11.	Y31	Male	52
12.	Y32	Male	48

No.	Code	Gender	Scores
1.	Z4	Male	68
2.	Z5	Male	48
3.	Z7	Male	68
4.	Z15	Male	64
5.	Z16	Male	56
6.	Z17	Male	80
7.	Z20	Male	48
8.	Z21	Male	44
9.	Z22	Male	48
10.	Z26	Male	60
11.	Z27	Male	44
12.	Z28	Male	48
13.	Z29	Male	76
14.	Z33	Male	52
15.	Z34	Male	64
TOTAL			3524
MEAN			55%

13.	Y34	Male	24
14.	Y35	Male	56

APPENDIX K

Distribution Table for Learners' Home Languages



Graph 4: Total mean score percentages according to the Home Language of participant learners for schools W, X, Y and Z.